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NEW YORK, OCTOBER, 1887.

THE dynamite gun, in which a shell containing dynamite or other high explosives is used, and in which compressed air is the projecting power, has apparently established its place as an efficient and formidable weapon for coast defense, if not for an aggressive attack. A range of some two miles has already been attained, and it is not improbable that this can be improved, while the projectile is capable of doing very much greater damage than that thrown by an ordinary gun of many times the weight of the dynamite gun.

The dynamite shell is practically an air-torpedo, with the advantage that its course can be regulated and directed with a much nearer approach to certainty, and with much simpler machinery, than that of the submarine torpedo, while its effective range seems to be much greater.

WHILE the work of preparing the Navy for war is going on, and new battle ships and cruisers are planned and built, the duties which frequently devolve on the service in time of peace should not be forgotten. To watch and protect commerce is, of course, the chief work of the Navy usually, and to enable it to do this efficiently there is needed—in Chinese and other Eastern waters, in Alaska, and for the squadron in the Southern Pacific especially—a class of small gunboats or dispatch boats to serve with the large cruisers. The service which these boats should perform is now devolved on a few tugs and old steamers, some of them almost unseaworthy and all poorly equipped and supplied with machinery of obsolete patterns. The work which they do is poorly done and at an unnecessarily great expense.

The vessels that are really needed are of small size and light armament, with engines of the latest and most economical patterns, and arranged to carry fuel for a cruise of considerable length. They would not be costly to build or arm, and would fully pay for themselves in a short time in the saving over the cost of running the ships now in use.

FROM the tables prepared for the English "Lloyd's," which probably approach completeness more nearly than anything else attainable, it appears that at the beginning of the present year the mercantile shipping of the world included 35,124 vessels, having a total registered tonnage of 20,943,650. Of these 9,969, of 10,531,843 tons, were steamers, and 25,155, of 10,411,807 tons, were sailing vessels; the steamers thus averaging nearly 1,100 tons each, while the sailing vessels averaged only about 400 tons.

An illustration of the modern tendency is found in the fact that while there was last year a small increase in steam tonnage, there was a decrease both in the number and tonnage of sailing ships.

The figures given, it must be remembered, include only sea-going ships, no vessels of less than 100 tons burden and no boats engaged in river or other purely inland navigation being included in the list.

Great Britain heads the list of shipowning countries, being credited with about 65 per cent. of the steam tonnage and 38 per cent. of the sail tonnage. The United States, while fourth in the list of steamship owners, having only about 8 per cent. of the steam tonnage, is given as second in sailing tonnage, having about 15 per cent. of the total of that class.

While over 96 per cent. of the steam vessels are reported as built of iron or steel, wood still holds an important place among the sailing vessels, about 80 per cent. of the tonnage (92 per cent. of the number of vessels) being of that material.

JUST at present a falling-off in the demand for steel rails and other supplies for new railroads is reported, although all the rail-mills and other works are very busy on orders which will require some months yet to fill. Those who watch the markets closely, also report that new railroad securities are now not taken up at all by investors.

As has been heretofore noted, the building of new railroad lines this year will probably reach nearly, if not quite, 12,000 miles. The construction of so great a mileage requires the investment of an enormous sum of money, and a large part of the surplus capital available for such purposes has probably been already invested, and its owners are inclined to wait and see the result before putting in more. Then, again, the immediate demands of traffic will be pretty well satisfied by the new lines now under construction, and there is not much disposition among the investing public to put their money into purely speculative railroads, in view of the events of the past few years.

There are quite enough of these speculative railroads building as it it, and a condition of affairs which will prevent the undertaking of more is not an unmixed evil. The speculative road is usually not only a waste of money in itself, but it is also a hindrance to legitimate enterprises which would really benefit the country.

THE Canadian Government has decided to send no more expeditions to Hudson's Bay in connection with the projected opening of a route to the Northwest. The Govern-

ment has come to the conclusion that the navigation of the bay is too uncertain, and the season too short to warrant the building of a costly railroad line to reach its waters. From present information it appears that the longest period of open navigation to the ports on Hudson's Bay is three months in a favorable season, while there is often less than two months of open water; moreover, masters of vessels do not like the voyage, as fogs are very common in the summer, and they always run the risk of being caught in the ice and compelled to winter in the bay. Under these circumstances this line could hardly be deemed a reliable one as an outlet for any considerable traffic, or, indeed, for any traffic which could find another route. Seen on the map the Hudson's Bay route from Manitoba looks like a direct and excellent one, but it is, unfortunately, too far north to be available for practical use.

The railroad from Manitoba to York Factory, or such other point on the bay as might be chosen, would be probably blocked by snow the greater part of the year. Its business would be almost entirely dependent on the navigation, for no local traffic could be hoped for beyond a few miles from Winnipeg. As the Government has practically, by its recent decision, put an end to all hopes of subsidy, the building of the road might as well be abandoned, and probably will be given up, although the talk about it may be kept up for a little while longer.

THE sixth convention of the American Street Railway Association, which will be held in Philadelphia, October 19, will be a meeting of unusual interest, owing to the important topics to be discussed. Ever since the Association was formed, the question of a substitute for animal power has been before it, but at no previous meeting has there been so much actual progress to be reported. The cable railroad has for some time been regarded as a success where an expensive plant is warranted by the traffic, and the experience now gained is sufficient to show that the electric railroad must be considered in all plans for the future. These and other questions will give the Association abundant material for discussion.

THE New England Railroad Club at Boston and the Western Railway Club at Chicago have opened their respective seasons in a manner which promises well, and a series of interesting meetings may be looked for through the winter. The Master Car-Builders' Club in New York has not, as this is written, yet completed its arrangements for meetings, but will doubtless do so before long.

SOME reference was made in this column last month to a plan for using electricity to increase the adhesion of locomotive drivers to the rails which was tried on the Central Railroad of New Jersey nearly 30 years ago. As then stated, no official record of the test seems to have been preserved in the offices of the company. Some of those who took part in them, however, are still on the road, and their testimony is that the trials were continued for some time on two or three engines, but with little or no success, and were finally given up with the conviction that the results obtained were not sufficient to warrant further use of the apparatus.

The arrangement used was a battery (or batteries) carried on the running-board of the locomotive, from which connections were made to the tires by means of a magnetic coil. No very definite description of the apparatus survives, however. It was the work of a French inventor named Quetil, we believe.

These experiments, however, were really of very little importance, and are only of interest as showing how present investigations were anticipated at an earlier day, when less was known about the subject of electricity than now.

THE derailment of a train by wind is not a kind of accident altogether unprecedented in this country. In the West and Southwest, such accidents occur nearly every year, the cyclones of those sections of the country sometimes upsetting trains with disastrous results. Similar accidents have also occurred among the mountain gorges of Colorado. An English contemporary mentions a wind derailment on the Southwestern Railroad of Russia, in which 18 freight cars were wrecked, as something almost if not altogether new. In the Russian case, the train was not on a steppe or prairie, but on a hillside, the wind being concentrated in force by sweeping through a long and narrow valley, corresponding thus to the mountain accidents in Colorado.

THE INCREASE OF THE AMERICAN NAVY.

THE people of the United States have, ever since the adoption of their constitution, been congratulating themselves—and with good reason too—that they are not obliged to maintain a large standing army and a costly navy. There is too much business shrewdness in the American character not to see the immense advantage we have enjoyed in being relieved of the obligation of constructing and maintaining a great army and navy. The money expended on these, in more senses than one, would be dead capital, and unproductive of the utilities of life and happiness. Our own civil war, however, suggested the possibility of foreign invasion, which it has often been feared might be invited by our defenseless condition. This fact and an overflowing treasury have created a very general and strong sentiment in favor of an increase of our navy and sea-coast defenses.

A great deal has been said of late years, too, of the need and the wisdom of the National Government granting aid, in the form of bounties or otherwise, to our foreign shipping. Attention has often been called to the fact that the British and other governments, by subventions of various kinds, help to sustain the great lines of steamers which maintain their commercial relations with all parts of the world, and hardly a session of Congress passes without some schemes being presented for the encouragement of foreign shipping or maintaining the National flag with "an appropiation."

During the last few years, large sums have been appropriated for the building of warships and the creation of a navy, and it now seems as though we are about to follow the example of European nations, in a policy which to them has been so costly and generally profitless.

Looking at the question from an economic point of view, it would seem as though it will be a great waste of money to build and maintain a large number of ships, which in time of peace will be useless, and then duplicate the expenditure for other ships to be employed in beneficial commerce.

Ordinary business common sense will suggest that if it be possible to build ships, which in times of peace could be employed for commercial purposes, and in case of war could be used for the National defense, that from a purely economical point of view, the country would be very much the gainer. It is, of course, true that a great nation must maintain a naval force, and that the men must be trained in actual service, and for that purpose there must always be warships. Besides this, one or more classes of vessels are needed for aggressive and defensive warfare, which are entirely unfitted for commercial purposes. But the exigencies, or rather, the evolution of modern naval warfare, have shown that at least one class of warships must have many features in common with the latest type of merchantmen. In the last report of Admiral Porter to the Secretary of War, it is said that:

In rehabilitating the navy we should ascertain as near as possible the method of fighting by single vessels and in fleets, in order to devise a system of classification which will enable us to use our ships in future combats in the most effective way.

In his report the Secretary of War says:

The experiences of the Department in its first attempt at the creation of modern vessels of war have been such as to excite the greatest concern and disappointment. An examination of the facts with reference to them demonstrated that an entirely new departure was necessary in undertaking further similar construction. The one characteristic which an unarmored cruiser must possess is great speed. This is determined by the function which she is expected to perform in modern warfare. She is a "commerce destroyer." She must be able to escape from iron-clads and outrun, so as to overhaul, merchantmen. If slower than iron-clads she could not keep the sea, and if slower than merchantmen she might as well stay in port. This division of ships by the functions which they are expected to perform is one of the things which has come about of recent years. When it became impossible to concentrate in one ship both the greatest speed, strongest armament and the highest defensive power, without reaching a tonnage displacement wholly out of the question, the division into classes, according to the functions which they are expected to perform, came about. Unarmored cruisers have become a distinct class, and the characteristic *absolutely indispensable to this class is very great speed.*

Admiral Porter says:

We have now reached a point where the greatest speed is demanded for a ship of war. A vessel making but 15 or 16 knots would be useless as a cruiser in time of war, for such a vessel could catch nothing and could not escape from a superior force.

Inasmuch as great speed is indispensable for this class of warships, and also for mercantile vessels engaged in certain kinds of traffic, it would seem to be possible to design ships which could be employed in either service, or at least they might be constructed for mercantile uses, but arranged so that alterations which would fit them for war purposes could be quickly and cheaply made.

The British Admiralty has acted upon this idea and has arranged for the maintenance of a reserve fleet of mercantile vessels suitable and available for use as armed cruisers.

In a communication of Mr. Farwood, Parliamentary Secretary to the Admiralty, to the Secretary of the Treasury, during the present year, it was pointed out that the vessels most likely to suit the purposes of the Admiralty were steamers of such high speed as would in all probability be used for the conveyance of mails and passengers, and it was further stated that the Admiralty considers that no vessel of a speed of less than 17 or 18 knots at sea would fully meet the object they have in view. It was said further that existing vessels, even with this speed, but which have not been built specially to Admiralty designs, would not be so valuable to the country as vessels which meet these requirements. If constructed to meet the views of the Admiralty they would be at a disadvantage in respect to their cargo-carrying powers, and, therefore, it would be a distinct advantage to the country if every reasonable encouragement were given to ship-owners to build and maintain this description of steamers in the trades that may be expected to support them.

Discussing the subject, the Secretary said still further:

The intention of a fleet of "Royal Naval Reserved Cruisers" would be obviously of great National advantage. In a pecuniary sense they would serve to limit the necessity felt by their Lordships for the construction of fast war vessels to protect the commerce of the country. Not only would the Nation be a pecuniary gainer in respect to the first cost of such vessels, but their annual maintenance, which amounts to a large sum, would be saved, were such vessels maintained while not required for Admiralty purposes in mercantile trading.

Regarding the conditions as to vessels to be built it is said:

Plans of two proposed new vessels to be forthwith constructed, and completed in about 18 months, or two years, have been laid before the Director of Naval Construction. That officer has reported that these plans would provide vessels far in advance of anything that has yet been submitted to the Admiralty for the purpose of armed cruisers. They would be of large size, of exceedingly high speed, provided with twin screws, have their engines and boilers placed below the water line, be divided into numerous compartments and have a protected steering gear. * * * Their coal capacity would be such that at a cruising speed they would probably keep the sea for a long period, probably not less than three months.

The question, of course, presents itself whether a ship can be designed which will be economical commercially and at the same time efficient or convertible into an efficient warship in case of need. The British Admiralty evidently are of the opinion that it is possible, and, undoubtedly, if the problem was presented of designing a ship which would be adapted to both kinds of service or which would be constructed with reference to being converted or altered into a warship, the ingenuity of naval constructors would devise methods of doing it.

The advantages of such a system would be very great. Our navy, or a considerable part of it, instead of being useless in times of peace, would be productive. Subventions paid to private parties would encourage and promote our shipping interests. The money paid for constructing and maintaining ships suited for war purposes would help to cheapen transportation, and the service would create a trained body of seamen. It would enlist the knowledge, skill, experience and interest of private parties in designing the most efficient ships for the dual service, and, for a given size of navy, it would lessen enormously the expenditure of the Government for the construction of warships.

THE STRONG LOCOMOTIVE.

A "report and opinion," by E. D. Leavitt, Jr., of tests of the Strong locomotive has recently been issued by the Strong Locomotive Company. The tests were made with three locomotives as follows:

ENGINE NO. 444

was fitted with Strong's patent twin furnace boiler and Strong's patent four-valve cylinder and valve-gear. It had cylinders 20 × 24 in.; six driving-wheels, 62⅜ in. diameter; heating surface in boiler, 1,848 square ft.; total

weight on driving-wheels, 90,000 lbs.; total weight of engine, 138,000 lbs.

ENGINE NO. 383

had an ordinary straight-top boiler, with fire-box over instead of between the frames, anthracite-coal grates, and fitted with Strong's patent cylinder and valve-gear, similar to that used on No. 444. Cylinders, 19 × 24 in.; four driving wheels, 65 11/16 in. diameter; heating surface in boiler, 1,385.9 square ft.; total weight on driving-wheels, 74,640 lbs.; total weight of engine, 99,520 lbs.

ENGINE NO. 357

had an ordinary boiler, similar to that of engine 383, excepting that it had a "wagon top" eight inches high, and a link-motion, common to American practice, with plain slide valves having De Lancey's balancing device. Cylinders, 20¼ × 24 in.; four driving-wheels, 66¼ in. diameter; heating surface in boiler, 1,572.1 square ft.; total weight on driving-wheels, 63,280 lbs.; total weight of engine. 90,720 lbs.

The tests were made in April and May, on the Lehigh Valley Railroad, between Wilkesbarre and Mauch Chunk, a distance of 55 miles. A round trip was made each day of the trial. This route is a continuous succession of curves as sharp as 14 degrees, and grades as steep as 96 ft. per mile.

The tests were made with passenger trains, consisting, usually, of eight cars on the northward trip and five southward, which weighed 421,500 lbs. and 253,000 lbs. respectively.

It is not easy to make any exact comparison from the experiments reported, because the loads, the quality of the coal and the sizes of the different engines varied so much. On page 9 of the report, a comparison is made of the coal consumption of each of the engines on two trips, when the same grade of coal (anthracite) was used, and, with one exception, the loads were the same. The performance of the engines on these runs was as follows:

Engine.	Pounds coal consumed.	Pounds water evaporated.	Average pounds water evaporated per pound coal.
No. 444	13,073	102,608	7.8
" 383*	14,883	84,098	5.6
" 357	16,174	96,936	5.9

From this statement it will be seen that the engine with the Strong boiler and valve-gear burned 3,101 lbs. or 19 per cent. less coal than engine 357 with an ordinary boiler and valve-gear did in doing the same work. Engine 383, with an ordinary boiler and Strong's valve-gear, burned 1,291 lbs., or 8 per cent. less coal than 357, although, in this case, on one of its runs engine 383 had a lighter train than 357.

It cannot escape attention, though, that engine 444 with the Strong boiler consumed more water in doing the same work than either of the others, which leads to the suspicion that it does not work dry steam. This excessive consumption of water of course has a marked effect on the evaporation of water per pound of coal. If we compare the total fuel consumption of engine 444 we find a difference, as stated above, of 19 per cent. in favor of the former, whereas it evaporated nearly a third more water per pound of coal than engine 357. In explanation of this, Mr. Strong in a letter to the *Railroad Gazette* says:

First, the fireman of No. 444 had not become sufficiently expert to prevent the blowing off of steam at stations and while running down grade without steam. Secondly, No. 444 has steel valves, which have not worn well, and which leak slightly; whereas the valves in No. 383 are cast-iron, which have worn as smooth as glass and kept perfectly tight. Thirdly, the engineer of No. 444 had not become accustomed to the engine, and carried his water so high that priming occurred; and fourthly, the valve gear of No. 444 was designed after the engine was nearly completed; having to be arranged to accommodate existing parts, its proportion could not be kept as accurately as those of 383's gear.

In comparing the performance of these engines, their relative weight should also be taken into account. Engine 444 weighs 38,480 pounds, or 38 per cent. more than engine 383, and 47,280 pounds, or over 50 per cent. more than engine 357. The heating surface of engine 444 is also much greater than that of either of the other engines. A large boiler always has an advantage over a small one when the small one is worked hard. For this reason, although the experiments show a marked economy of the Strong engine over the one of the ordinary type, yet they are not conclusive with reference to the question of the relative economy of the two classes of engines of the same size and weight. The practical question usually is: "Into what form can a given number of tons of iron and steel be put so as to make the most efficient and economical locomotive?" It is doubtful whether this question can be answered by comparing engines as dissimilar in size and weight as those were which were the subjects of the experiments reported on.

The inventor of the Strong locomotive and the company with which he is associated have shown so much enterprise in building engines of this type that every opportunity should and doubtless will be given to them to show what they can do; but to be conclusive a comparison must be made of two engines of similar weight and dimensions, working under the same conditions.

Of course, much allowance should be made for a new machine of this kind. The men who run it are inexperienced in its use and probably not able to work it to the best advantage; and more or less modification of details must always be expected in a machine which is as great a departure from old practice as the Strong engine is, in order to get the best attainable results. Our criticism is not intended as an expression of doubt of the success of this form of locomotive, but is meant to imply that further experiments are needed to demonstrate its capabilities.

* On one trip northward the train which this engine drew weighed only 374,300 lbs. instead of 421,500 lbs. in all the other northward runs.

Accidents to Employes on British Railroads.

THE last accident report of the British Board of Trade gives some interesting statistics of accidents to employés on the railroads of that country. For the 10 years from 1877 to 1886, inclusive, the number reported is as follows:

	In Train Accidents.		In Other Accidents.	
	Killed.	Injured.	Killed.	Injured.
1877	22	154	620	2,009
1878	15	156	529	1,847
1879	8	118	444	1,836
1880	23	118	523	1,962
1881	19	168	502	2,278
1882	21	153	532	2,423
1883	11	87	543	2,373
1884	23	115	523	2,204
1885	13	81	438	2,036
1886	4	81	421	1,929

The proportion of deaths and injuries to the total number of employés is given for each year in the report; it is, however, based on estimates only, except in the year 1884, when a special return made to Parliament gave the total number of men employed on the railroad lines of Great Britain as 346,426. Accepting the estimated figures, however, as nearly correct, the returns show that there has been a continuous and marked decrease in the proportion of casualties. In 1877, there was 1 person killed to 414 employed, and 1 injured to 123; in 1886, the proportions had fallen to 1 in 815 killed and 1 in 172 injured, a very substantial improvement. This improvement, moreover, was not spasmodic, but steady and continuous.

As to the relative dangers involved in the different kinds of employments on railroads, the following table is given. In this, the Board takes the total number of employés killed and injured (in train and all other accidents) in 1886, and compares them on the basis of the return of 1884, the Board believing that the total number of employés has not changed since then greatly, or indeed more than it ordinarily fluctuates from month to month. This table is as follows:

	Total No.	Killed.	Injured.
Station-masters	6,165	1 in 1,027	1 in 1,027
Brakemen and goods-guards.	7,407	1 in 192	1 in 18
Permanent-way men	37,840	1 in 411	1 in 261
Gatekeepers	1,605	1 in 321	1 in 535
Engine-drivers	12,874	1 in 1,609	1 in 90
Porters and shunters	48,070	1 in 546	1 in 84
Firemen	12,795	1 in 711	1 in 65
Inspectors	3,518	1 in 586	1 in 207
Passenger guards	5,902	1 in 2,951	1 in 100
Pointsmen and Signalmen	19,012	1 in 1,728	1 in 487
Laborers	70,405	1 in 1,902	1 in 977
Ticket collectors, etc.	2,060	1 in 1,030	1 in 1,038
Mechanics	55,940	1 in 6,213	1 in 2,331
Other classes	62,833	1 in 604	1 in 411
Total	346,426	1 in 815	1 in 172

Some of the conclusions above shown accord very nearly with our experience in this country. That the proportion of casualties should be very high among brakemen and goods-guards (or freight conductors), among porters and shunters (or yardmen) and among engineers and firemen we would naturally expect; but why gatemen should stand only second in the proportion of killed is not easy to be seen.

Nearly 30 per cent. of the deaths and over 60 per cent. of the injuries not due to train accidents were due to operations connected with the shunting or shifting of cars. The car coupler is a question intimately connected with the safety of trainmen in England as well as here.

The following table shows the number killed and injured in shifting or yard work, the first column giving the casualties resulting directly from coupling or uncoupling cars; the second, the total number of shifting casualties its figures therefore necessarily including those of the first column as well:

	Coupling.		All Shunting.	
	Killed.	Injured.	Killed.	Injured.
1877	..	...	167	1,175
1878	44	313	124	1,051
1879	25	304	99	1,047
1880	40	298	127	1,141
1881	35	377	125	1,339
1882	34	429	121	1,556
1883	45	395	130	1,449
1884	29	341	91	1,320
1885	36	267	138	1,236
1886	23	301	119	1,168

It can hardly be said that this table shows an improvement, although the figures for 1886 are somewhat better than those for the preceding year. At best, it may be said that the increase in accidents of this class has not been greater than that in mileage and traffic, and that they have remained about stationary.

Assuming the same basis as that taken by the Board of Trade in the table given above, and taking the classes of men usually employed in shifting operations, we find that in 1886 the proportion of casualties was 1 in 466 killed and 1 in 47½ injured in all shifting work; 1 in 2,412 killed and 1 in 184 injured in the actual coupling and uncoupling of cars.

It is very much to be regretted that there are no statistics in existence which would make a comparison possible between the railroads of Great Britain and those of the United States. On the railroads of Massachusetts, in 1886, the average number of persons employed was 31,188, and the total number of casualties to employés reported was 63 killed and 211 injured; an average of 1 in 495 killed and 1 in 148 injured, or a very much worse showing than that made by the English railroads. Some of this difference may be due to the fact that the English returns include a larger proportion of warehouse laborers and station men, who can hardly be said to be exposed to the usual dangers of railroading.

In Massachusetts, in the same year, 2 men were killed and 105 injured in coupling cars; in this case, so far as a comparison can be made, it does not seem as if much advantage could be claimed for either side.

NEW PUBLICATIONS.

REPORT OF THE AQUEDUCT COMMISSIONERS OF NEW YORK CITY; by the President, James C. Spencer, containing Reports of the Secretary, John C. Sheehan and of the Chief Engineer, Benjamin S. Church, giving a Review of the Work of the Aqueduct Commission to January 1, 1887, including the Plans and Work of Construction of the new Croton Aqueduct to that date, and the proposed Dams and Reservoirs and other Appurtenances of the same, made in accordance with the Resolutions of the Aqueduct Commissioners.

This is a large quarto book, very elaborately illustrated with lithographs and prints by the Photo-Gravure Company, of New York. The report of the President gives a history and brief description of the development and progress of the great work. The Secretary's report gives statements of the appropriations and the amounts expended each year since the inception of the construction of the Aqueduct, with a list of the officers and engineers employed on the work.

The report of the Chief Engineer is the most interesting and valuable portion of the volume. It is accompanied with elaborate tables, profiles and diagrams, giving data concerning the water supply from the Croton River and the rainfall in its basin. There are also a series of tables and diagrams giving the particulars relating to contracts, progress of work, constructors' plant, etc.

The photo-gravures show the various structures, both permanent and temporary, which have been erected along the line of the aqueduct and illustrations taken in the interior of the tunnels with electric lights. There are a large number, between 40 and 50, of these illustrations, which show the work in its various stages of progress. These are followed by 32 full-page "progress profiles," showing the rate at which the work has advanced. Elaborate maps and profiles show the location of the aqueduct, and the various gate-houses, arrangement of pipes, overflow structures, shafts, sections of masonry, waste weirs, machinery, instruments employed, plans of reservoirs, dams, etc., are shown by a series of some 60 lithographed drawings, which are exquisite specimens of the draftsman's art.

Altogether, the book is a model of its kind, the expense of which is justified by the magnitude of the work entrusted to the Commissioners and the Engineers.

REPORT OF THE PROCEEDINGS OF THE TWENTIETH ANNUAL CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

This report has been very promptly issued by the Secretary, and this year contains 211 pages, about the usual number. Its general character does not not differ materially from the reports published in previous years.

BOOKS RECEIVED.

R. UNIVERSITA ROMANA, SCUOLA D' APPLICAZIONE PER GL' INGEGNERI: ANNUARIO PER L' ANNO SCOLASTICO 1887-88, PROGRAMME D' INSEGNAMENTO; INDICE GENERALE DELLA BIBLOTECA. Rome, Italy; issued by the Royal University.

ANALES DE INGENIERIA: ORGANO DE LA SOCIEDAD COLOMBIANA DE INGENIEROS. Bogota, Colombia; issued by the Society, Manuel Antonio Rueda, Director.

TICKET AGENTS' AND TRAVELERS' RAILWAY, STEAMSHIP AND STEAMBOAT GUIDE: VOLUME I, NUMBER I, SEPTEMBER, 1887. New York, 51 Park Place; Henry G. Marsh, Editor and Proprietor. This new guide or manual is especially useful to ticket agents, but travelers will also find it of value. It contains a great deal of information in a compact form.

POOR'S MANUAL OF THE RAILROADS OF THE UNITED STATES: 1887. New York; H. V. & H. W. Poor. This is the twentieth annual issue of the well-known *Manual*, which has come to be accepted as a standard work.

THE UNIVERSAL TINKER AND AMATEURS' ASSISTANT: SEPTEMBER, 1887. New York; Hodgson & Bertrand. This is a new monthly journal, issued by the publishers of the *Builder and Woodworker*. Its purpose is well indicated by the title.

ANNUAL REPORT OF THE COMMISSIONER OF PATENTS: 1886. Washington; Government Printing Office.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY: ABSTRACT OF PROCEEDINGS OF THE SOCIETY OF ARTS FOR THE TWENTY-FIFTH YEAR, 1886–87. Boston; issued by the Institute.

THE NEW CROTON AQUEDUCT OF NEW YORK: REPORTS OF THE AQUEDUCT COMMISSION, 1883–87. New York; published by the City. This volume contains the reports of President James C. Spencer, Secretary John C. Sheehan and Chief Engineer Benjamin S. Church, and is accompanied by a large number of plates showing the progress of the work and many interesting points in relation to it.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION: PROCEEDINGS OF THE TWENTIETH ANNUAL CONVENTION. Chicago; issued by the Association. This report of the convention held in St. Paul last June appears with commendable promptness.

BREAKAGE OF WHEELS AND TIRES ON BRITISH RAILROADS.

(*Concluded from page 427.*)

The year 1881 apparently closed the period when breakages of tires were considered of importance enough to need investigation, for since that year there have been no cases in which such accidents have been specially reported on to the Board of Trade by its Inspectors.

The total number of accidents reported as occurring from breakages of wheels and tires in the five years from 1882 to 1886 was as follows:

	Broken tires.	Broken wheels.	Total.
1882	1,149	1	1,150
1883	1,247	3	1,250
1884	1,060	2	1,062
1885	920	1	921
1886	866	1	867

No persons were reported killed or injured in any of these accidents except in one, in 1882, when three passengers were slightly hurt. That they were generally of a slight nature is further shown by the fact that it was not considered necessary to enquire into any of them.

The general remarks of the Board of Trade on this class of accidents, for the years named, indicate that there had been a general improvement in the methods used of fastening tires to the wheel-centers, and that to this improvement was due the generally slight nature of these accidents. While many cases of broken tires still occur, there are comparatively few in which the tire leaves the wheel altogether, as was noted in many of the earlier accidents. By far the greater number of breakages were under freight cars, where injury to persons is not likely to result; and a large number were merely slight breaks, which disqualified the tire for further service, but did not result seriously to the train.

As in former years, the breakages of wheels, apart from the tires, were so few in number as hardly to deserve special mention.

The Mineral Riches of the Caucasus.

(From the *Revue Scientifique.*)

THERE is hardly any portion of the globe which is as rich as the Caucasus in different minerals. In all the country known as Transcaucasia, from the chain of the Caucasus on the north to the Persian frontier on the south, and from the Caspian Sea on the east to the Black Sea on the west, minerals and metals abound.

The government of Yelizavetpol merits special mention; it is one of the richest provinces of ancient Armenia; the sub-soil of whole districts consists of an ore of copper rich in metal (10 to 20 per cent.) which crops out in many places. Other valuable ores are also found, notably argen-

tiferous galena yielding up to 17 per cent. of silver and 60 per cent. of lead. There are also deposits of iron ore—principally magnetic and specular ores—with 70 and even 80 per cent. of metal. Cobalt is also found there in considerable quantities.

Iron ore, in various forms, is equally abundant in the government of Tiflis, at Tchatah, in the districts of Charopan and Ratcha, and at Batoum, where argentiferous copper is also found.

Gold is found in some quantities in Mingrelia and in the bed of the River Ingour.

The oxide of manganese (MnO^2) exists in large quantities in the governments of Koutais, Tiflis and Yelizavetpol; at present it is only worked in the Valley of Kvirilla, in Koutais.

The government of Erivan has, besides other minerals, enormous deposits of rock-salt.

Sulphur is found in a native state in several places, especially in Daghestan, where it is regularly worked.

One of the most valuable riches of the Caucasus consists in the well-known deposits of petroleum in the Apcheron peninsula, near Baku, and northwest of the Koubon Range. There are good reasons for believing that this valuable product is also to be found in large quantities on the shores of the Black Sea, between Poti and Batoum, near Ozourgeti. Borings have been in progress there for some time.

In other parts of the country there exist deposits of minerals of less importance; among these are zinc, antimony, saltpeter, soda, marble, gypsum, ochre, lithographic stone, fire-clay, ozokerite, etc.

For the working of mineral deposits on a large scale, two things are necessary: Cheap and abundant fuel, and facilities of transportation.

The country is traversed by the railroad from Batoum to Poti and Baku. The places richest in minerals are at a distance from that line varying from 10 to 50 miles. There are good roads reaching the railroad and numerous water-courses which might be utilized in improving communications. The cost of wagon transportation is still low in the Caucasus, especially in the eastern portion of the country.

As to fuel, the western portion of the Caucasus is heavily wooded, the eastern section much less so. Wood, however, is not indispensable; the country possesses a valuable fuel in the refuse from the petroleum refineries, known as "Astatki" or "Mazout." Its calorific power is high and it is easily transported. Besides this, there are important deposits of coal in the government of Koutais, at Tkvibouli. The workings at that place have just been connected with the railroad and will soon be in a position to furnish fuel advantageously to all the country. Labor at the coal mines and elsewhere is now very cheap and fairly reliable.

In addition to the advantages already mentioned, is the further one of easy access to the extensive market of Russia, and also to the markets of the neighboring countries, Turkey and Persia.

While many of these minerals have long been known to exist, the workings have been only on a small scale to supply local needs; the methods used have been very rnde and primitive.

A beginning has, however, been made, and so far with success. The firm of Siemens has, for 20 years, worked the copper mines at Kedabek, in the government of Yelizavetpol. This year a French company has bought the silver mines at Achtala, and has commenced its workings there.

Very little has been done heretofore, because the people of the country have had neither the technical knowledge, the enterprise, nor the capital needed for operations on a large scale. The Caucasus can, however, become the seat of a great industrial activity, for which it presents so many advantages.

The great drawbacks to be encountered are the variety of dialects spoken by the natives of the country and the fact that they are not accustomed to regular work; and, above all, the corruption and maladministration of the Russian Government officials. For these difficulties a foreigner must be prepared.

OBITUARY.

JOSEPH S. SALISBURY, who died at Missouri Valley, Ia., August 31, aged 44 years, was born in Jefferson County, N. Y., but went West at an early age. He practised law in Iowa for a time, but some years ago settled in Chicago and became Editor and one of the proprietors of the *Industrial World*. He has conducted this paper with much success. He has been in failing health for some months past.

J. B. CLOUGH, whose death at Helena, Montana, August 23, was briefly noted last month, began work as an engineer in the capacity of an assistant in the location of the Mobile & Ohio in 1849. In 1851, he was on the Cleveland & Pittsburgh, where he remained several years. In 1860, he was Chief Engineer of the Evansville, Henderson & Nashville. In May, 1861, he was appointed Constructing Engineer of the United States military railroads in Virginia, and organized a construction corps, which he commanded until December, 1864, when he resigned on account of ill-health. At that time he was Brevet Colonel of Volunteers. In 1867, he resumed work and was appointed Chief Engineer of the Hastings & Dakota Railroad. In 1869, he was elected City Engineer of Minneapolis, and, in 1870, he became Chief Engineer of the Minneapolis & St. Louis road and remained in that position for several years. In 1880, he entered the service of the Northern Pacific Railroad, having charge of the construction of the bridge over the Missouri River at Bismarck and its approaches. For some time past he has had charge of the location and building of branch lines in Montana for the company.

Contributions.

The Proportions of Locomotive Cylinders.

To the Editor of the Railroad and Engineering Journal:

REFERRING to the article in the September number of the RAILROAD AND ENGINEERING JOURNAL, on "Proportions of Locomotive Cylinders," on page 414, you give

$$\sqrt{\frac{\frac{60{,}000}{4} \times 61}{136 \times 26}} = 16.1 \text{ (or } d\text{)}.$$

If you try it as it is written, the result is absurd; it should be

$$\sqrt{\frac{\frac{60{,}000}{4} \times 61}{136 \times 26}},$$

or the square root of the whole.

Again, on page 415, try the formula for weight as given, of which I enclose a sample, and the result is also ridiculous. The formula should be

$$\frac{d^2 (P \times 0.85 \times S)}{C \times D} = W,$$

or else the C should not be taken as $\frac{1}{4.25}$, but 4.25, a constant.

For years I have maintained that engines have been, and mostly are, over-cylindered, and I am glad to notice that others are coming to the same belief.

J. H. AMES.

[NOTE.—In his first exception our correspondent is partly right. The radical sign $\surd$ was intended to cover the whole fraction, but the printer, not being a profound mathematician, did not make it quite long or comprehensive enough, and so there is fairly a doubt as to its correctness as it stands.

The error in the last formula must be laid to the committee which made the report. As pointed out by our correspondent, the value of C should be 4, 4.25 or 4.5,

instead of $\frac{1}{4}$, $\frac{1}{4.25}$, or $\frac{1}{4.5}$. The formula $\frac{d^2 \times S \times P \times 0.85}{D}$ will give the tractive power of the cylinders. Obviously the weight on the drivers should be four times the tractive power, if the adhesion is taken at $\frac{1}{4}$ the weight on the wheels.—EDITOR RAILROAD AND ENGINEERING JOURNAL.]

Pillsbury Flouring Mills at Minneapolis.

ONE of the sights in Minneapolis which most strangers are taken to see are the Pillsbury flouring mills. There are three of these, Mill A being the largest. A card which is handed to visitors gives the following facts: "Mill A grinds 9,500,000 bushels of wheat yearly, and has a capacity of 7,000 barrels of flour daily. It makes more flour than any other two mills on the globe, and could feed two cities as large as New York."

It is located on the Mississippi River, which furnishes the water power. The water is brought to the mill by an arched tunnel 50 rods long and 20 ft. high by 16 ft. wide. There are two turbine wheels, manufactured by the Stillwell & Bierce Manufacturing Company, of Dayton, O. The turbines are 55 in. diameter and have 52 ft. head of water, and are each of 1,200 H. P. Besides the water power the mill has an additional reserve steam power, consisting of a compound engine of 1,600 H. P., which is supplied with steam by ten steam boilers. The engine was made by Edward P. Allis & Co., of Milwaukee, and has 5 ft. stroke with two cylinders, one 60 and the other 32 in. diameter. The fly-wheel is 24 ft. diameter with 5-ft. face and a shaft 14 in. diameter and makes 70 revolutions per minute. The wheel weighs about 30 tons. Its belt consists of three-ply heavy leather, 5 ft. wide, and drives a pulley 16 ft. diameter. The steam power is used only in time of low water, which may occur either in the cold or the dry season of the year.

The mill is 115 ft. wide, 175 ft. long and 20 ft. high, and is eight stories high. The basement is chiefly occupied by heavy machinery and its appurtenances. To a person who knows nothing about milling machinery, excepting what he learned in his youth, the wonderful variety and ingenuity of the machinery employed in one of these modern structures is quite a revelation. The processes of making flour and the product have been wonderfully improved, and a visitor can understand why it is no longer possible for smaller mills to compete with these enormous establishments.

Methods of Securing Tires on the Wheels.

THE accompanying engraving, fig. 1, represents a plan largely used for some time past in Austria, in Germany and in Belgium; the Southern Railroad Company of France has applied it to all the wheels used on its passenger carriages and freight cars.

This system consists of a ring or circular key, *A*, of steel, which is rolled or hammered in a straight bar and cut off to a fixed length, the ends being cut at an angle of 45°. This bar is then bent or curved, either hot on a mandril or cold on a system of three rolls, and is sprung into place as soon as the tire has been forced on the wheel-center.

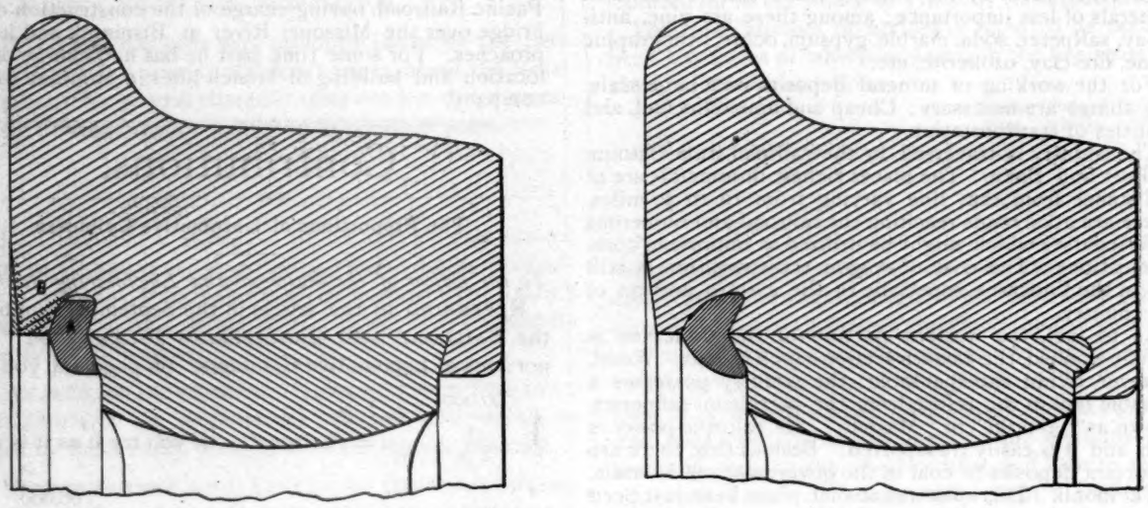


Fig. 1. Fig. 2.

METHODS OF SECURING TIRES TO WHEELS.

Both the tire and the wheel-center have the exact form of the inner side of the ring, and the channel or groove in the tire is made as shown by the dotted lines in the drawing. As soon as the tire has been shrunk on the center the lip *B* is hammered down, thus fixing the ring in place and preventing all displacement. This method of fixing the tire gives absolute security in case of breakage, as the tire cannot leave the wheel.

The second drawing, fig. 2, shows a plan for securing tires adopted by M. Rodieux, Chief Engineer of Material and Motive Power of the Western Railroad of Switzerland at Yverdon, and used by several of the Swiss railroads. This system differs from that shown in fig. 1 only in the more simple form of the key, and also of the grooves in the tire and in the wheel-center to which it is applied.

CHOMIENNE.

COUZON, FRANCE, July 30, 1887.

THE MILLER PLATFORM AND COUPLER PATENTS.

(*Continued from page 402.*)

IN this article it is proposed to deal with the questions which arose as to the 1865 patent of Miller. The complainants seemed to place much stress upon this patent, and especially upon the fourth claim. Originally the first claim also of this patent was pressed, but upon the hearing this claim was abandoned and no testimony regarding it was offered.

The first claim was as follows:

1st. So constructing hooked head car-couplings that they are adapted to receive links and other forms of couplers and form connections therewith, substantially as described.

This is effected in the Miller structure of 1865 by boring a vertical hole through, and by having a horizontal slot in the hooked head. In this way an ordinary link and pin can be used in connection with the Miller mechanism.

It seems evident that, after such holes had been bored and slots provided in other forms of couplers, no invention was required to do the same thing in the case of the Miller structure. The defendants produced a number of old patents, long prior to Miller's patent of 1865, which showed various forms of couplers, the arrangements of which were such as to greatly limit the scope of Miller's patent, and, according to the views taken by the defendants, one of these old patents showed Miller's invention. As this claim was withdrawn during the trial, nothing more need be said about it here, especially as it is not a matter of interest connected with the trials of the case.

The fourth claim was the one upon which stress was placed. This claim reads as follows:

4th. Locating an elastic buffer in the end of the buffer-beam *A*, of a platform which is elevated so as to be brought in a horizontal plane with the bed of the car-body, substantially as described.

Both sides understood that what was meant by the "end" of the buffer beam *A* was the center of the beam or the extreme end of the platform longitudinally of the car.

The accompanying drawings, taken from the patent of

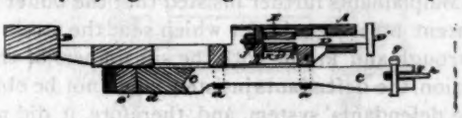


Fig. 7.

MILLER PLATFORM, 1865.

Miller, will give an understanding of the devices as shown in the patent.

The first cut gives a longitudinal section of the platform and bolster beam, showing also the coupler attached to the car. The second cut gives a view of the bottom of the platform and bolster beam, also showing the coupler.

Now it becomes interesting to see exactly what Miller said about this elevated platform in his patent, and it will be found that he said very little.

Another object of my invention is to provide for connecting together each one of a train of cars in such manner that the lateral jerking motion of a train, and all the unsteadiness and injurious effects occasioned thereby, will be effectually prevented, providing at the same time for resisting the longitudinal shocks occasioned by suddenly starting and stopping a train of cars, employing for said purposes a contrivance which is located in a line with the strongest part of a car-body—viz.: the flooring timbers—as will be hereinafter described. * *

As my invention is applicable to cars which are constructed in the usual manner, I have only represented in sheets 1, figs. 1, 2 and 3, the platform and longitudinal supporting beams thereof of one end of a car. I will, however, state that, in order to carry out one part of my invention effectually, it is desirable to have the transverse buffer-beam *A* of the platform frame elevated, so as to bring it in or nearly in a plane with the car-bed or frame timbers of the car-body. This will bring the platform or floor thereof in a horizontal plane, or nearly so, with the floor of the car without necessarily elevating the transom *B*. * * * *

Above the coupling hook *C*, and extending longitudinally through the buffer beam *A*, and into the framework of the platform, is a buffer-shank, *D*, which is constructed with an enlarged head, *D'*, on one end and a round or cylindrical extension, D^2, on the other end.

It will be seen out of the matter quoted but one meager sentence refers particularly to the elevated platform. The other sentences quoted referring to the location of the buffer, its construction and arrangement.

The first thing to be noted is that Miller does not claim an elevated platform *by itself;* he only claims such a platform when an elastic buffer is located in the position shown. When a thing is not claimed in a patent by itself, but only in combination with some other device, the separate devices making up the combination are supposed to be in and of themselves old in the art.

Thus the inference from reading the fourth claim of Miller's patent is that elevated platforms were old, but that they had never before his time been combined with elastic

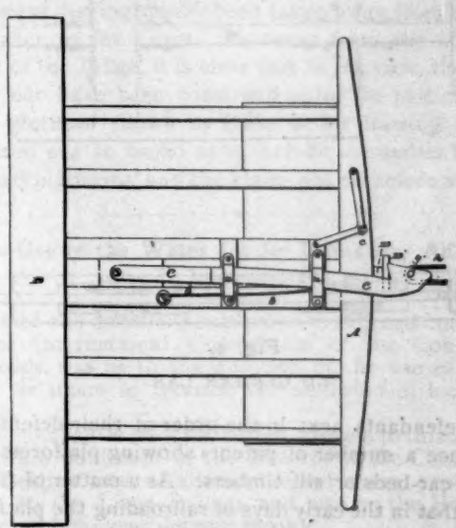


Fig. 8.

MILLER PLATFORM, 1865.

buffers located in their ends. The complainants at the trial made a great point of the benefit arising from the use of elevated platforms, *per se*, which point was admitted by the defendants. The defendants, however, asserted that the elevated platform as used to-day was not by itself the invention of Miller. To prove this, the defense put Mr. Calvin A. Smith upon the stand. Mr. Smith is the Superintendent of the Union Tank Line. From or about the year 1854 to 1874, Mr. Smith was employed as General Foreman and Superintendent of the Car Department of the Erie Railroad. In the year 1862, at the Erie shops, three cars were put in the course of construction, having elevated platforms. The Erie road was a broad-gauge road, the cars rocked a good deal and it was desired to lower the car-bodies as much as possible.

To do this and still keep the draft-line at the then normal height above the rails, required that the car-bodies should be lowered without lowering the couplings. This could only be done by elevating the platform, or rather keeping the platform at its then height, while the car-body was lowered.

The draw-bar passed through the center of the buffer-beam. In this way, which was substantially in accord with modern practice so far as the platform was concerned, Smith says he built three cars—one was put in use in May, one in June and the last in September, 1863. Miller, it is said, was in and out of the Erie shops at that time, and from the testimony it is probable that he saw some or all of the three cars.

No testimony was offered by the complainants which it is thought shook Mr. Smith's evidence. Mr. Palmer R. Post was put upon the stand by the complainants, and he swore that he did not remember seeing the cars described by Smith, though he was connected with the Erie Railroad at the time.

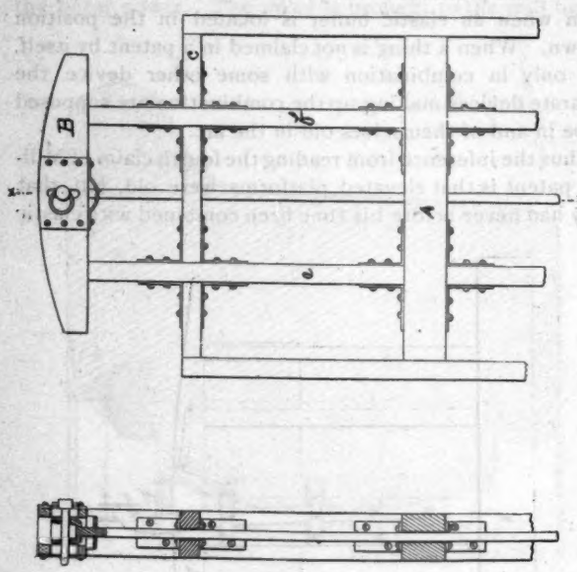


Fig. 9.

OLD GERMAN CAR.

The defendants next in the order of their defense put in evidence a number of patents showing platforms level with the car-beds or sill timbers. As a matter of fact, it appears that in the early days of railroading the platforms were usually made level with the sill timbers by carrying the sill timbers out beyond the car-body and thus forming the platform. This form of structure was departed from when the wheels were increased in diameter, the car-body consequently raised, while the draft-line was kept at the same height. This brought into use the depressed platform, which finally gave way in time to the elevated platform, now used with the more elevated draft-line.

The defense relied largely upon a drawing appearing in an old German publication entitled *Organ für Eisenbahn Wesen*, Vol. 5, page 49. This publication was printed about 1850. In it is shown a drawing of a car. The car has four longitudinal timbers or sill beams. It has a bolster-beam and a buffer-beam. There is a coupler and buffer at the center of the buffer-beam. As will be seen from the drawings given, it is impossible to tell therefrom whether the center sill timbers were stopped at the bolster-beam, or whether they were halved into the beam, or exactly how the parts were arranged in this regard.

However, this structure showed an elevated platform exactly in line with the sill timbers of the car. The complainants said it was not an "attached platform," that is, one which could be taken off for repairs, but that to repair it would require a rebuilding practically of the whole car-bed. It was suggested in answer to this by the defendants that the Miller drawing itself did not show how the sill timbers were to run, the top of the bolster beam being as high as the top of the platform, and that the Miller patent was as blind as the German drawing.

The complainants in answer to this said that the longitudinal sill timbers of the German car were to be halved into the bolster.

The third cut (fig. 9) is a drawing of the old German car. Steps were used and the platform was narrow to allow of their use.

Referring to the above drawing, *A* is the bolster beam, *B* is the buffer beam and *C* is the front transverse sill beam. From the drawing it is clear that the two outside longitudinal beams ran to the beam *C*, that the two center-beams were stopped at the beam *A*. Now the defendants insisted that the beams *e* and *f* were halved into the beam *C*, while the complainants insisted that the beam *C* was made in three pieces and that, therefore, the structure was a weak and useless one. It is submitted that to any mechanic the plain interpretation of the drawing is that the beams *e*, *f* and *C* were halved into each other.

The defendants next in the order of their defense showed numerous examples of cars having buffers located in the end beam of the car-body as in the case of English cars, and insisted that the question of an "attached" platform was immaterial. The English cars were all provided with side buffers, but it is to be borne in mind that the cars of the Pennsylvania Railroad Company had no central buffer through the end beam of the platform or buffer-beam. The buffers, it is true, were not separated in the cars of the Pennsylvania Railroad Company to as great an extent as in the English cars, but, nevertheless, they were not central or axial buffers, and it was merely a question of degree in this regard between the English buffers and the buffers of the defendant corporation.

The complainants further insisted that the buffer of the 1865 patent must be a buffer which sent the strain backward through and in line with the sill timbers of the car. This action, the defendants insisted, could not be obtained with the defendants' system, and, therefore, it did not infringe, as no buffing strain could be imparted to the car above the pivot of the yoke lever, and the location of this pivot is some inches below the sill timbers. This the defendants considered a point of such importance that in itself it should have been sufficient to win them the case. (See previous cut of Janney device in earlier number.)

There is nothing in the 1865 patent of Miller which confines the invention strictly to a buffer which went entirely through the buffer-beam, and consequently the defendants insisted that the invention was met by cars having level platforms with buffers upon but not through the end beam.

The fourth cut (fig. 10) shows cars so constructed.

The drawing is taken from the patent of Peter Alverson, No. 908, September 8, 1838, and shows that it was very old to use buffers on the buffer-beam of a platform level with the car-body.

In this same connection the patent of Turner, granted in 1848, showed a car having a level platform, made by extending the sill timbers of the car, and having a buffer

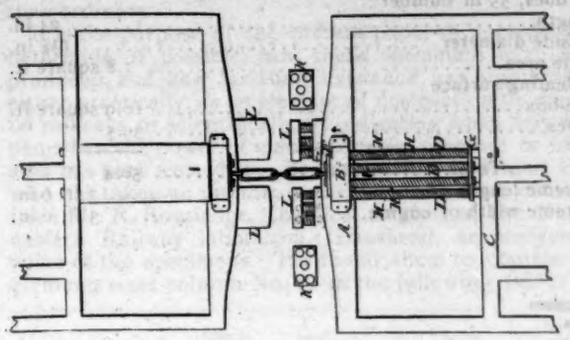


Fig. 10.

ALVERSON CAR, 1838.

in the buffer beam. This buffer is just below the sill timbers, but, as the Pennsylvania Railroad Company cars have the point of strain of the buffers below the sill timbers, this Turner patent was urged as a good reference.

The fifth drawing (fig. 11) is a cut showing an end view of this car. The buffers were also to act as coupling devices, and were likewise to put the brakes upon the wheels.

To these old patents the complainants replied that in each case no "attached platform" was shown, and that a platform made by the extension of the longitudinal timbers of the car would not meet the Miller patent of 1865,

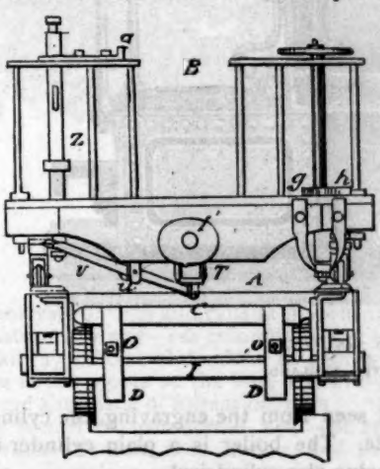


Fig. 11.

TUMER CAR, 1848.

which was limited, so the complainants said, to an "attached platform." The Court in this matter, during a discussion between counsel in the absence of the Jury, gave its views on the subject of this claim. The discussion arose as to how the claim should be understood; complainants insisting that it was limited to an elevated platform made by attaching the timbers of the platform to the sill beams, while the defendants insisted that this made no difference, and that however the platform was elevated, whether by attaching the beams to the sills by bolting them thereto or by carrying out the sill beams, was of no consequence, and that Miller had claimed *any* elevated platform with a buffer at its center or in its "end," as he called it, independently of the question how, mechanically, the platform was elevated. If the Court had charged the Jury in accordance with the complainants' view the defendants had no anticipation. If the Court had charged the Jury in accordance with the defendants' view, then the old German car was clearly an anticipation of the claim of Miller.

This is what the Court said in part:

I have read the patent through, and I confess I find no warrant in the patent itself for saying that there is any mode or method of constructing elevated platforms in it. If it is an elevated platform—that is in the sense that it is on a level with the car timbers—it seems to me that is all that is contemplated in the claim. I do not see how you can import into that claim any particular way of getting that platform on a level with the sill timbers. One can do it in one way, and one can do it in another; however he does it he has infringed Mr. Miller's claim. * * * *

It does not make any difference how you get your platforms up. * * * *

He (Miller) could not have intended to cover any particular construction of platform by that claim (the *4th* of the 1865 patent) or he would have put it into his claim, and not having done that the fact that the drawings show it (a particular method) does not affect the question at all. * * * *

How can I say, however, that he means one kind of platform made in a particular way. I do not see anything to justify it.

From the above it is clear that the Court, if the case had gone to the Jury, would have given such instructions to them that they would have had to have found that the old German car showed a structure which met the claim. This is the only way in which this claim was passed upon, the patent having finally been taken away from the Jury altogether by the Court. However, from the above remarks of the Judge, it is clear that in his view, the patent could not have been construed as for the particular elevated platform shown by Miller in his drawing, but that the claim was so broad as to include the earlier forms of elevated platforms, and the claim was therefore void.

The Use of the Water Jet for Increasing Adhesion in Locomotives.

ONE of the questions submitted to railroad companies, by the International Commission of the Congress of Railroads, was as to the question of the use of a jet of water or steam to increase the adhesion of locomotive wheels.

The companies have submitted answers to this question, which are published in the *Bulletin* of the Commission. The Belgian State Railroads report some experiments made on the Liège inclines, and also on the Hockai inclines, with no very definite results.

The Eastern Railroad of France made a few experiments which resulted in nothing.

The Mediterranean Railroad of Italy submitted an elaborate report by Chevalier J. Silvola, which informs us that experiments were begun in 1879 on the Pontedecimo–Busalla Line, which were so successful that the water-jet was applied to 35 of the eight-coupled locomotives used on the heavy grades of that line. This resulted in a considerable saving, the expenditure for sand having been 20,000 francs a year, while the cost of the steam or water-jet was only about 2,500 francs.

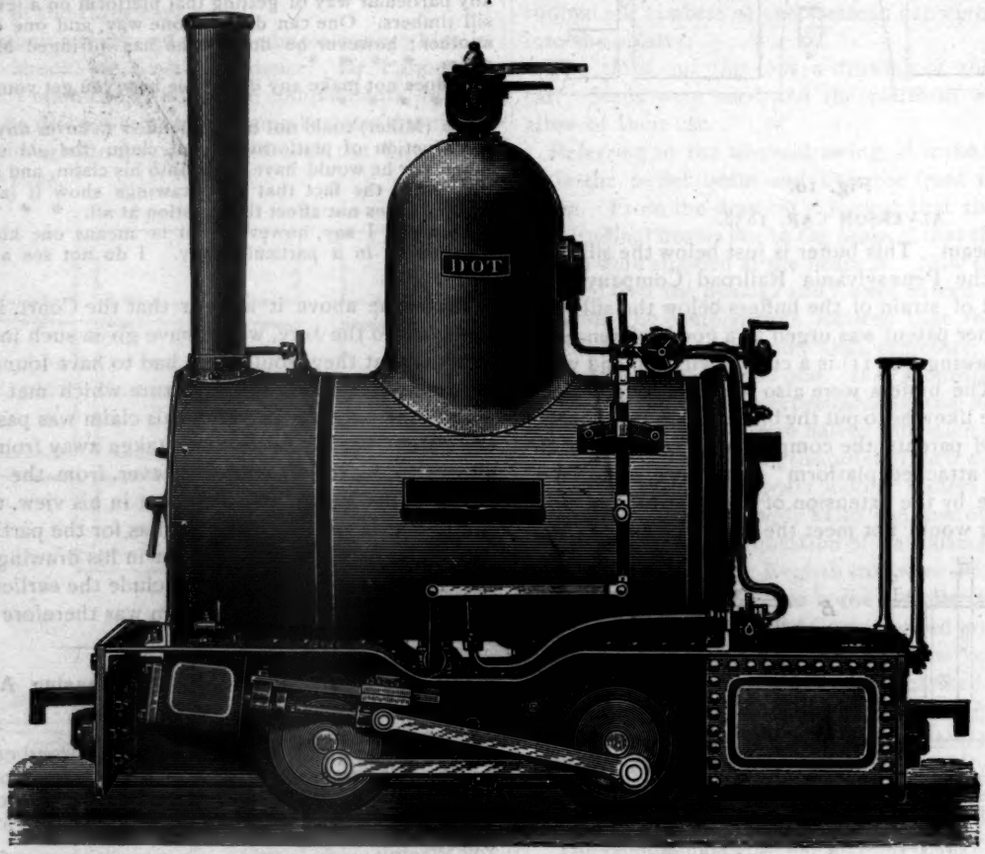
An incidental advantage was the absence of the sand, which at one time proved a serious obstacle in the way of maintaining good drainage in the Giovi Tunnel.

The further opinion is advanced that while the adhesion is not increased quite as much by the use of water as of sand, the water-jet system has the advantage in that it does not interpose any resistance to the movement of the train as does the sand, more or less of which remains on the rails. The engine-drivers much prefer the water-jet system as they say it makes the train lighter—that is, it

draws more easily. It is stated also that the abandonment of the use of sand is accompanied by a lessening of the wear of rails. This result is supported by numerous observations, and is further corroborated by the observations of M. Couard on the Sorderettes Tunnel of the Paris, Lyons & Mediterranean Railroad, and those of M. Egger on the Swiss Central Railroad.

The water-jet system, it has been said, will not answer in cold climates, but it has been very successful on the Swiss Central and the Gothard lines, both of which are subject to very low temperatures. The Gothard Railroad has 55 locomotives fitted with the water-jet, and thoroughly approves the system. On this road, although there are long tunnels and steep grades, making the use of heavy locomotives necessary, the wear of the rails has been much lighter than was expected.

Total wheel-base	33 in.
Boiler, diameter	27 in.
" length	51 in.
Fire-box, cylindrical:	
Diameter	17 in.
Length	27¾ in.
Tubes, 55 in number:	
Length	24 in.
Outside diameter	1⅜ in.
Grate area	1.8 square ft.
Heating surface:	
Fire-box	10.9 square ft.
Tubes	39.5 " "
Total	50.4 " "
Extreme length of engine	7 ft. 6 in.
Extreme width of engine	3 ft. 0 in.



SHIFTING LOCOMOTIVE OF 18 INCHES GAUGE.

BUILT BY BEYER, PEACOCK & CO., GORTON, MANCHESTER, ENGLAND.

The results so far obtained justify the making of extended experiments with the water-jet system, in the opinion of the Commission.

The Smallest Locomotive.

As an example of a very small locomotive we reproduce herewith, from *Industries*, an engraving of a locomotive shown at the Manchester (England) Jubilee Exposition, by Messrs. Beyer, Peacock & Co. The engine is intended for switching and moving material through shops and yards, and several of this class are in use in the works of the firm at Gorton, Manchester. Several have also been built for use in the Lancashire & Yorkshire Railway shops at Horwich.

The leading dimensions of this engine are as follows:

Gauge	18 in.
Cylinders, diameter and stroke	5 × 6 in.
Number of wheels, 4; diameter	16¼ in.

As will be seen from the engraving, the cylinders are placed outside. The boiler is a plain cylinder in form, the fire-box being also cylindrical.

The tank carries 25 gallons of water. The total weight in full working order is 3¼ tons.

Steel Scale Produced by Skidding Railroad Wheels.

[Paper read before Section G, British Institution, by Jeremiah Head, Vice-President of the Section.]

WHERE a heavy gradient or incline occurs upon a railway, necessitating the frequent and severe use of brakes to prevent too rapid descents, pieces of metal of a peculiar form, resembling the leaves of ferns, have frequently been found alongside the rails. A close examination of the specimens will satisfy the observer: (1) That, though differing in size and color, they have all the same origin and the same cause. (2) That being found on steep inclines only, they are probably due in some way to the

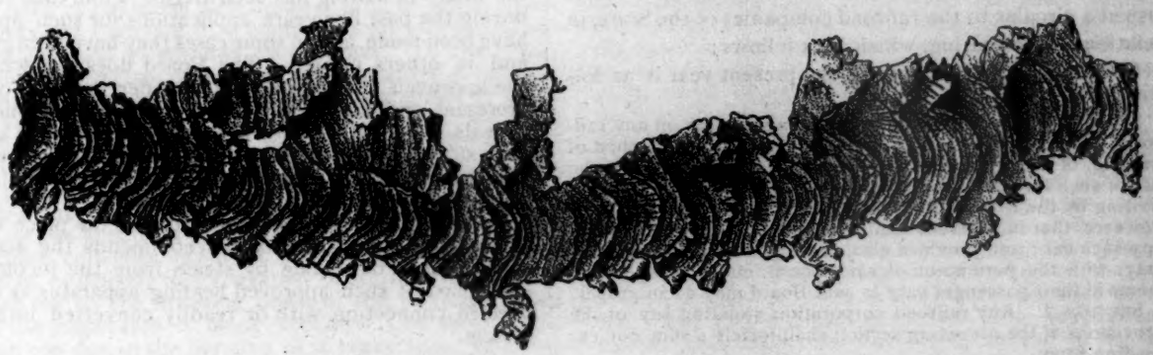
action of the brakes of descending trains. (3) That being —as will hereafter be shown—of steel, they must have come from the tires or rails and not from the brake blocks. (4) That in assuming their present form they have undergone considerable pressure, and at a temperature higher than ordinary.

It is the purpose of the present paper to consider and determine, if possible, how these specimens have been produced, and how far their existence has significance, either practically, as an element of destruction or danger on railways, or scientifically, as indicating what may happen when the power of metals to resist pressure or abrasion has been exceeded. By favor of Sir Lowthian Bell, who has taken an interest in the matter, I have obtained from Mr. R. Routledge, Chemical Analyst at the Northeastern Railway laboratory, Gateshead, an analysis of some of the specimens. He found them to contain the elements—see column No. 1—in the following table:

		Specimens.	Tires.			Rails.			Greatest resemblance to
Column No.		1	2	3	4	5	6	7	8
			from	to.	Average.	from.	to.	Average.	
Phosphorus....	(P)	.06	.04	.05	.045	.03	.07	.05	Rails.
Sulphur.....	(S)	.07	.01	.09	.062	.04	.14	.07	Rails.
Carbon.....	(C)	.57	.24	.63	.486	.35	.60	.475	Tires.
Silicon.....	(Si)	.09	.16	.33	.274	.04	.10	.07	Rails.
Manganese.....	(Mn)	.79	.21	.52	.390	.80	1.00	.90	Rails.
Tin	(Sn)	.07	—	—	—	—	—	—	—
Iron.....	(Fe)	98.35	—	—	98.742	—	—	98.435	Rails.
Total.....		100.00			100.00			100.00	

Mr. Routledge has also been good enough to give me collected specimens of the abraded iron and steel cuttings, which had evidently been caused by skidding of wheels while passing over curves on falling gradients. At that time we came to the conclusion that these cuttings came from the tires of goods brake vans, while going down inclines with the brake fully on. The goods guards have brake vans weighing 10 tons, and have the power by their own brakes to skid the wheels should they find it necessary. The specimens consisted of both iron and steel, and might come from either rail or tire; but I am inclined to the opinion that, except in case of worn rails, they for the most part come from the tires. They are, in my opinion, torn off when the wheels are skidded, and while passing round sharp curves when the rails are somewhat worn. With continuous brakes, we do not skid the wheels, except when the drivers keep the full power on to the end of the stop, and then they may skid, just before the train is brought to a stand only. We find that tires which frequently pass over inclines wear out only in proportion to the duration of time the brake is applied, and to the number of such applications of the brake. During the applications of the brake, more especially if the wheels are skidded, sharp curves and crossings are greater factors in the destruction of tires than inclines where brakes are applied without skidding. Tires wear into flat places, indicating skidding, but only in the case of guards' brake vans and of wagon tires when spragged, and which work frequently over inclines where spragging is necessary."

The opinions I have quoted, although, perhaps, not in all cases very decided, seem to incline to the belief that the specimens have been torn from the *tires* rather than from the *rails*. Mr. Routledge, however, whose opinion I invited, takes a somewhat different view. He thinks that they come from the *rails* and *not* from the *tires*.



STEEL SCALE PRODUCED BY SKIDDING RAILROAD WHEELS.

typical analysis of tires and rails at present in use on the Northeastern Railway—see columns Nos. 2 to 7 inclusive.

The railway official who—as far as I know—first called attention to the pieces on the line, and who studied them at the time and place of formation, says: "I beg to state that the pieces of iron found near the rails leave the wheels whilst the train is in motion, and the wheels are skidding. Therefore, you will perceive it would be difficult to determine which wheels they come off." Again, he describes them as "pieces of iron, picked up on the incline, that have left the wheels by abrasion with the rail."

Mr. Charles Markham, of Staveley, to whom I am indebted for information and assistance, says: "I am certainly under the impression that the pieces are rubbed off the tires, but the matter has not been, as far as I know, investigated by any competent authority. My attention was drawn to the subject some four or five years ago, in consequence of a signalman having collected a number of specimens in his box, at the foot of an incline. For many years I had a good deal to do with the working of the Likey incline, near Bromsgrove. This appeared to me a place where there would be plenty of them. I believe that wherever there are inclined planes, and brakes are used, similar specimens could be obtained."

One of our most experienced locomotive superintendents, whose opinion I asked upon these specimens, has kindly given it as follows: He says, "Some years ago I

An examination of column No. 8, which shows whether the proportion of each element found in the specimens inclines most toward what is usual in rails or in tires, favors this view. It will be seen that in every case except that of the carbon, where the difference is very slight, the analysis agrees most nearly with that of rails. As compared with rails, the tires analyzed seem to be characterized by high silicon and low manganese, which is not the case with the specimens. The presence of a small quantity of tin is somewhat remarkable; but Mr. Routledge informs me that that element occasionally occurs in pig-iron.

Inasmuch, however, as the blows or charges of steel are often run indiscriminately into ingots for rails or for tires, and, as it cannot be stated certainly what was the composition of the identical tires and rails concerned in forming the specimens analyzed, it is scarcely prudent to found any strong argument upon these analyses.

Such shavings as these, rubbed off from the surface of tires or of rails whenever a wheel is skidded, indicate, for the time being, very rapid destruction.

The lesson taught, or rather re-taught (for it has often been inculcated before), is that wheels should *never be skidded*. But, on the other hand, trains, whether passenger, goods or mineral, should always be retarded by braking a sufficient number of wheels to effect the desired object with a pressure somewhat short of skidding. Skid-

ding wheels is indeed a barbarous and ineffectual attempt at retardation, whilst it is a most effectual cause of disintegration.

The specimens looked at from a scientific point of view, are interesting. Their color indicates that they have been formed at a high temperature, as they have clearly all been originally coated with magnetic oxide—Fe_3O_4. The comparatively large body of metal forming the rail, and its continual presentation of new surfaces during skidding, make it improbable that it could have reached any high temperature; whereas skidded wheels might easily present the same surface long enough to accumulate heat locally to a greater extent than could be, *pari passu*, dissipated by conduction.

The multitude of folds which appear in all the specimens, and the tendency to spread into various forms, seem to indicate that under the pressure to which they have been subjected the metal has "flowed" with great freedom.

Reviewing the evidence obtained so far, the writer inclines to accept the following conclusions, viz.: (1) That the pieces have come from the tires of skidded wheels, and not from the rails; (2) that they were produced at a sufficiently high temperature for the formation of magnetic oxide, *i. e.*, at a red heat; (3) that they were forced out from behind the skidded wheels—the folds being on the under side—until from their accumulated length and weight they fell off; (4) that the only way to avoid the destructive action which they indicate is to brake more wheels to an extent short of skidding.

Car-Heating in Massachusetts.

THE Railroad Commissioners of Massachusetts have issued a circular to the railroad companies of the State, in relation to car-heating, which is as follows;

Chapter 362 of the Acts of the present year is as follows:

SECTION 1. No passenger, mail or baggage car on any railroad in this Commonwealth shall be heated by any method of heating, or by any furnace or heater, unless such method or the use of such furnace or heater shall first have been approved in writing by the Board of Railroad Commissioners: provided, however, that in no event shall a common stove be allowed in any such car; and provided also, that any railroad corporation may, with the permission of said Board, make such experiments in their passenger cars as said Board may deem proper.

SECTION 2. Any railroad corporation violating any of the provisions of the preceding section shall forfeit a sum not exceeding $500.

SECTION 3. This Act shall take effect upon its passage.

This Act became a law on the 6th day of June last, and, on the 25th day of June, this Board issued a circular to the railroads asking for a statement as to their respective outfits for heating cars. These statements were furnished as promptly as could have been expected, and yet more than a month elapsed before full returns from the roads were received.

In the summer time it is impossible to make satisfactory practical tests of heating apparatus, and yet it is necessary for the Board, without delay, to approve in writing of some methods of heating, of some furnaces or heaters, so that the corporations may not be obliged to choose between heating the cars illegally and suffering them to go unheated.

An examination made last winter of the practical working of the Emerson, Martin and Sewell systems satisfied the Board that the use of steam from the locomotive promises better results in the four great elements, of safety, comfort, simplicity and economy, than any other device known, and the Board hereby approves of the method of heating cars by steam from the locomotive at low-pressure, and recommends that each railroad should at once prepare to make practical tests of the system during the coming winter.

While, however, the results already obtained by the various inventors using this system are remarkably satisfactory, and while the Board believes that this system will eventually largely supersede the use of separate heaters, it nevertheless realizes that further improvements are probable, and that difficulties, especially with reference to local trains, are still unsolved. It is worthy of note in this connection that the President of the Connecticut River Railroad, in response to the above mentioned circular of this Board, dated June 25th, states that:

Seventeen of our cars are heated by the Emerson Car-Heating System, and are used only on our local trains. * * * This system we have found to be very simple in its construction and management, and less expensive than heating cars by stoves.

The importance of securing uniformity of steam-pipe couplings and of providing in many cases for the heating of a car when not attached to a locomotive are obvious.

The separate heater cannot, at present, be wholly dispensed with, nor would it be possible for the railroads to make so radical a change before cold weather sets in. The cars must be heated. The chill of the unheated car would probably kill more people than the flames from broken heaters. Death would ensue not so suddenly but none the less surely.

Chapter 54 of the Acts of the year 1882 reads as follows:

Every drawing-room or sleeping car, passenger, baggage, mail and express car, owned or regularly used on any railroad in this Commonwealth, in which heating apparatus may be placed, shall be provided with such safeguards for protection against fire as may be approved in writing by the Board of Railroad Commissioners. Any corporation violating the provisions of this section shall forfeit for each offense $300. The provisions of this section shall take effect the first day of November, 1882.

Since the passage of the foregoing act the use of heating apparatus not provided with safeguards approved by the Board in writing has been illegal. From time to time, during the past five years, applications for such approval have been made, and in some cases they have been granted and in others refused. The Board does not withdraw the approvals heretofore granted under the Act of 1882 aforesaid, and hereby, for the present, renews such approvals, provided, however, that in no event shall a common stove be allowed in any passenger, mail or baggage car, the use of such stoves being expressly prohibited by the aforesaid Act of the present year.

In selecting heating apparatus to take the place of the "common stove," the Board recommends the adoption of the system of heating by steam from the locomotive, or at least of such approved heating apparatus as can be used in connection with or readily converted into such system.

ACCIDENTS ON BRITISH RAILROADS.

THE number of accidents reported on British railroads in the year 1886, as given in the Board of Trade returns, was given in the JOURNAL for July, page 309; briefly repeated, that statement gave a total of 119 collisions, 1,772 derailments and 25 other accidents, or 1,916 accidents in all. The fuller report, which has now appeared, shows that of these accidents 62 in all have been inquired into or investigated by the Inspectors of the Board.

The remarks of the Railway Department of the Board on the results of these investigations are as follows:

1.—Defects of Permanent Way: Seven investigated accidents occurred in this class, resulting in the death of 6 passengers and injury to 37 passengers and 4 servants of companies. One of the accidents was attributed to the want of proper super-elevation of the rail at the junction of a left-hand with a right-hand curve; one to distortion of the rails in a curve by excessive sun heat, combined with the want of proper expansion intervals between the rail-joints, to an insufficiently ballasted road and to a speed too high for the condition of the road; two to obstructions getting upon the rails; one to the line not being properly ballasted; and one to the failure of a driver of a train to observe the signal given him by the plate-layers at work relaying the track. In one case, had

there been an automatic brake on the train, the guard might have applied it and stopped the train in time to have prevented the accident; another accident was in some measure attributed to goods-wagons being placed in front of passenger-carriages in a mixed train.

2.—Defects of Equipment: Under this head 8 accidents were investigated, resulting in injury to 116 passengers and 4 servants of companies. One of the accidents was due to the breaking of the stay-rod of a van; one to the worn condition of the flange of a wheel under a wagon in a mixed train; two to the fracture of the axle of a wagon in a mixed train; one to oscillation of a van of a mixed train, due to the brasses not being of the best shape; one to the defective state of a wagon; and one to the fracture of the draw-bar of a wagon of a goods train.

3.—Trains Entering Stations at too Great Speed: Under this head 4 accidents were inquired into, by which 15 passengers and one servant of a company were injured. These four accidents were in each case due to the want of care of the driver. In two of these the driver might have stopped in time, had there been a continuous brake upon the train; in another, had the engine as well as the train been fitted with continuous-brake apparatus, the accident might have been avoided.

4.—Collisions at Junctions: Under this head 10 collisions were inquired into, by which 41 passengers and 13 company's servants were injured. Three of the collisions were due to the fault of signalmen; six were due to the engine-drivers not keeping a good look out for the signal; one was due to the mistake of a brakeman. In three instances the collisions were due to the want of block working, or to a defective system of block working; and in four instances the collisions might have been prevented had there been a good continuous brake upon the train.

5.—Collisions within Fixed Signals at Stations: Under this head 25 collisions were inquired into, by which 2 passengers and 1 servant of a company were killed, and 256 passengers and 30 servants were injured. Of these collisions the principal causes may be summarized as follows: Eight were mainly due to mistakes of signalmen in block working, arising from forgetfulness or want of care; two were due to the combined mistakes of signalmen and engine-drivers; six were mainly due to want of care on the part of engine-drivers in running their trains at too high a rate of speed, not having them under proper control, or not keeping a proper look out for signals. Some of these collisions occurred under very trying circumstances, in densely foggy weather or during snowstorms, which led to the breaking down of the telegraph wires and the suspension of block working. One serious collision was due to the bursting of a brake tube; one was due to the freezing of water in the vacuum brake pipes. In four instances had the trains been fitted with continuous brakes the collisions might have been avoided; in one instance the automatic action of the continuous brake was valuable in mitigating the effect of the collision; and in another the superiority of an automatic brake over a non-automatic brake was shown.

6.—Butting Collisions: Under this head one accident was inquired into, by which 1 servant of a company was killed and 5 hurt.

7.—Accidents in consequence of Engines or Trains being wrongly turned into Sidings or otherwise through Facing Points: Under this head 4 accidents were inquired into, by which 4 passengers were injured. Two of them were due to an accumulation of snow preventing the points from being accurately closed. One was due to the mistake of a signalman, lowering the wrong signal for the train to proceed; and one was due to a breach of the rules for block working.

8.—Accidents on Inclines: Under this head three accidents were inquired into, by which 29 passengers and 2 of the companies' servants were injured. Two accidents were due to the want of caution in coupling operations on steep gradients and the want of sufficient brake power on the carriages; one was due to the wagons of a mixed train becoming uncoupled on an incline.

9.—Accidents to Servants of Railway Companies Generally: There were 23 railway servants killed and 301 injured whilst employed in coupling and uncoupling of vehicles; 96 were killed and 867 injured whilst employed in various shunting operations; 18 were killed and 54 injured by being caught between vehicles; 10 were killed and 24 injured by falling between the train and platform; 87 were killed and 118 injured whilst working on the permanent way and sidings; and 81 were killed and 111 injured whilst walking, crossing or standing on the line on duty.

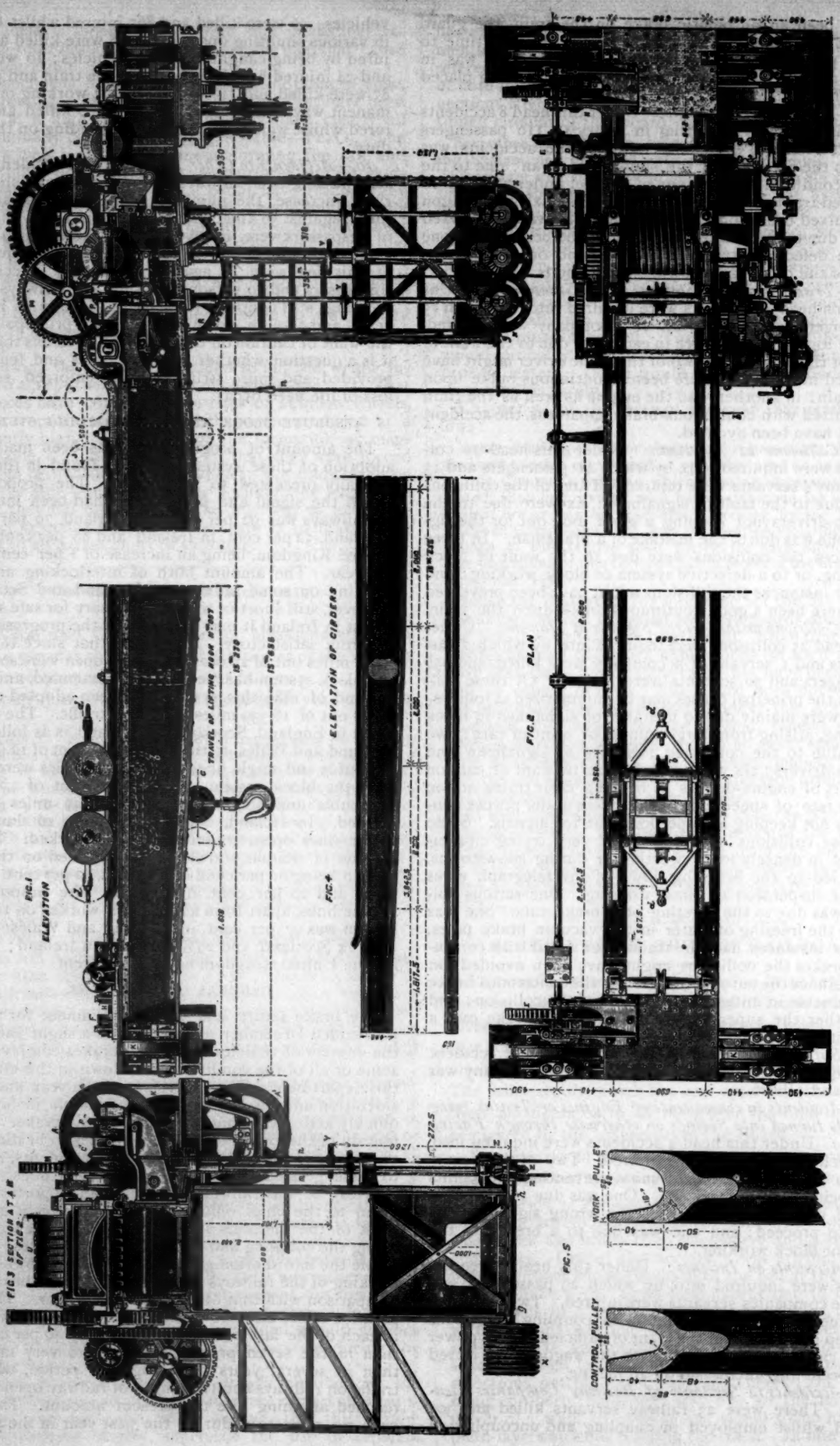
10.—Accidents to Other Persons: The accidents to persons passing over railways at level crossings show a serious increase, the numbers being 81 killed and 25 injured, against 58 killed and 21 injured in 1885. The number of trespassers were, however, only 205 killed and 91 injured, against 250 killed and 126 injured in 1885. The number of suicides were 80, against 55 of 1885. Accidents to trespassers and to persons crossing the railways at level crossings still continue to be quite as large as in former years, and though, no doubt, they are principally due to the want of caution on the part of the persons themselves, it is a question whether, if better gates and fences were provided and more stringent rules enforced, so great a loss of life need occur.

ABSOLUTE BLOCK AND INTERLOCKING SYSTEMS.

The amount of progress that has been made in the adoption of these systems may be found in the returns annually presented to Parliament. The proportion in which the signal and point levers had been interlocked on railways was 92 per cent. in England, 79 per cent. in Scotland, 52 per cent. in Ireland and 88 per cent. for the United Kingdom, being an increase of 1 per cent. during the year. The amount both of interlocking and block working on some railways in England and Scotland is, however, still short of what is necessary for safe working; whilst in Ireland it may be said that the progress made is far from satisfactory. It appears that since 1873, when 6,217 miles out of 16,082 miles then open were so worked, the block system has been largely extended, and that at the end of 1886 this system had been adopted on 14,639 miles out of 18,339 miles open for traffic. The progress made in England, Scotland and Ireland is as follows: In England and Wales, at the end of 1886, out of 12,946 miles of double and single lines open, 11,866 miles were worked upon the block system. In Scotland, out of 2,786 miles of double and single lines open, 2,249 miles were so worked. In Ireland, out of 2,607 miles of double and single lines open, 524 miles were so worked. The proportion of double and single lines worked on the block system being 91 per cent. in England, 80 per cent. in Scotland, and 20 per cent. in Ireland. The proportion of double lines, apart from single lines, worked on the block system was 97 per cent. in England and Wales, 97½ per cent. in Scotland and 29½ per cent. in Ireland; the total for the United Kingdom being 93 per cent.

GENERAL OBSERVATIONS.

The brake return laid before Parliament for the half-year ended December 30, 1886, shows a slight increase in the number of vehicles fitted with brakes complying with some or all of the conditions laid down in the circular of this department. The experience of the year under consideration adds to the evidence adducible in favor of a quickly acting continuous and automatic brake. The attention of the Board of Trade continues to be directed to the means employable for preventing accidents, not only to passengers but to the servants of companies. By the courtesy of the railway companies, an opportunity was given to the chief officers of the department of seeing most of the methods suggested with the view of facilitating the coupling and uncoupling of vehicles. On the whole the information given in this report shows that the working of the railways during the year 1886 bears a fair comparison with that of the preceding year. The comparative tables also show that the number of the inquiries in each of the last two years were fully 40 per cent. less than in the seven preceding years, and very much less than in several years preceding that period, when the traffic on railways and the length of railway open had not reached anything like the present amount. There has been no relaxation during the past year in the progress



50-FT. TRAVELING CRANE; PARIS, LYONS & MEDITERRANEAN RAILROAD SHOPS.

made for rendering railway working more safe by the extension of interlocking and absolute block systems over a larger railway mileage. The extension of these improvements, which is made from year to year, as well as the re-arrangement of stations, the heightening of platforms, the provision of foot bridges and subways, and of continuous footboards to carriages, all of which matters have met with considerable attention from the railway companies, will tend to lessen the number of accidents and add to the safety of the traveling public.

A FRENCH TRAVELING CRANE.

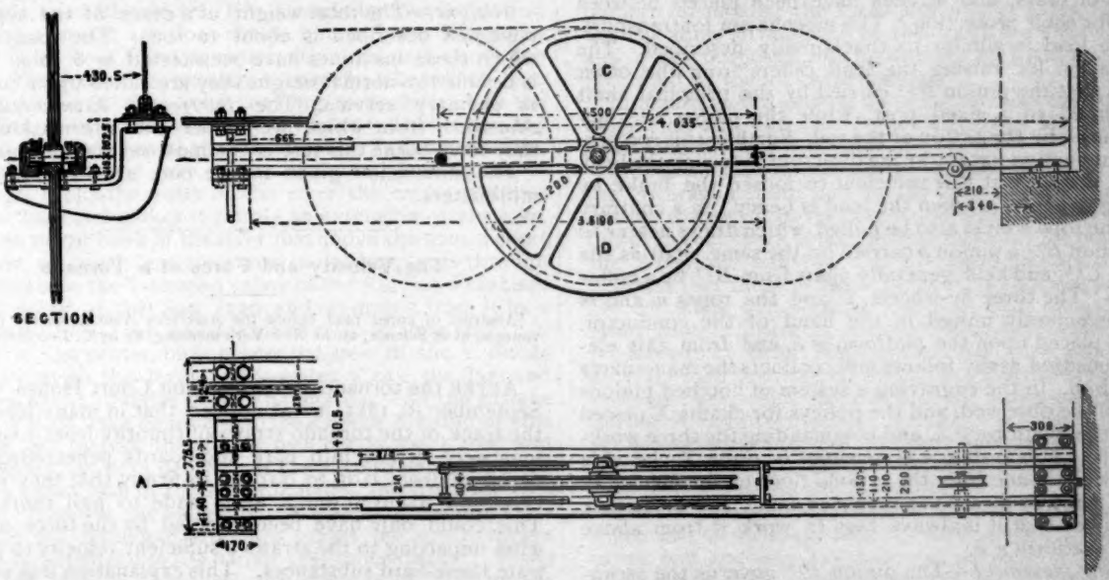
THE accompanying engravings show a traveling crane of 50 ft. span and a lifting capacity of 3 tons, which is in use in the boiler shop of the Paris, Lyons & Mediterranean Railroad at Oullens, France.

These cranes are worked by the shop engine by means of a fly-rope.

The same rope governs the four cranes of the central nave, one of which is of 20 tons power, the others being of 3 tons each. The engraving represents a crane of 3 tons power. It must be remembered, however, that the dimensions of the rope by which it is worked, and of which we are about to give some details, have been calculated in regard to the 20-ton crane. This rope is of 8 tton; it is 1 in. in diameter, of three twists, without any central cord. These twists are themselves composed of 25 strands each; they are twisted in a contrary direction to the rope, and have 13 to 14 turns to the meter. Thus formed, the cable should weigh about 1 lb. per yard, and should have a breaking strength of about 2 tons. Before being adjusted, it is steeped in a mixture of 25 part of tallow to 10 of resin and submitted for 10 days to a tension of 100 kilos. When in work, it is again coated with 16 parts of tallow to 10 of resin, as occasion requires. The driving pulley of the rope is placed at one extremity of the factory. It is 4 ft. in diameter, and makes 319 turns per minute. At the other end of the factory, being a distance of about 170 meters, the rope returns over another pulley of the same dimensions as shown by the engraving. Fig. 5 represents the grooves of both the pulleys. The pulleys by which the rope sets in motion the mechanism of the cranes have grooves of the first type; those which receive the cable on its return have grooves of the second type. All along its course, the cable is supported by brass rollers 6 in. in diameter, 12 meters apart. When acted on by the cable, these rollers revolve at the rate of 2,546 turns per minute. So great a speed requires that the rollers should have their centers of gravity rigorously placed in the axis of rotation, and that their axes should not be allowed to have too much play in their sockets. Taking the lineal speed of the cable to be 20 m. per second, as indicated, it has been calculated that the following speeds per minute are obtained for the divers movements of the crane:

	Cranes of 20 tons.	Cranes of 3 tons.
Speed in raising a weight	0 m. 610	8 m. 090
Speed in transporting a weight	9 m. 500	9 m. 220
Speed in transporting the crane from one end of the factory to the other	8 m. 965	9 m. 105

Description of traveling crane.—The frame is composed of two large iron girders and angle irons, resting at each extremity on two transverse double T-iron girders of 6¼ in. × 4¾ in. × 0.39 in. These latter are parallel with the ground; the rollers are placed between them, to which they are suspended by forked bolts. On the side where the rope runs, a third girder of double T-iron, parallel to the two first, and having the same transverse section, serves with them to sustain the pulleys A^1, and directs the rope over the driving pulley A. Each of the large girders is formed of an iron web of 0.39 in., which varies from 2 ft. deep in the middle to 16⅜ in. at the extremities, of two flat flanges 6¼ in. × ½ in. from one end to the other, and of four connecting angle irons 2⅜ in. × 2⅜ in. × 0.39 in. Each of the webs is formed of three plates, which are joined together by double-joint covers of 12 in. × 0.39 in. The plates of the lower flanges have their ends joined by joint-covers of 31.5 in. × 6¼ in. × ½ in. Those of the upper ones have no joint-covers. Fig. 4 gives the longitudinal section of the large girders. Rails are fixed on



the large girders, along which runs a four-wheeled wagon, *J J*, which carries the load. This is sustained by an iron chain of 0.6 in. fixed to the hook *a*, at one end of the crane, passes over the two pulleys *b*, attached to the wagon, and over the movable pulley *c*, and rolls up over the barrel of the windlass *U* at the extremity of the crane. This disposition is the same as that of the hand crane described in our April number; it enables the wagon to run from one end of the crane to the other without either raising or lowering the load. The wagon is moved by means of an endless iron chain of 11 mm., the ends of which are fixed to the two ring bolts *d d* of the wagon, rolling over the pulley *f f* at one part, and over the nut *P* at another.

Working Mechanism.—The fly rope enters the crane by one of the pulleys A^1, which it quits vertically over the pulley *A*, describing a half circle; after this it again descends over the second pulley A^1, by which it leaves the crane. The pulleys A^1 are simple return pulleys; the pulley *A*, on the contrary, drives the whole mechanism. It is keyed on to its shaft, which consequently turns continually while the cable is in motion; no other part of the mechanism is set in motion by this movement, unless it be previously arranged so as to effect one of the three actions, raising of the load, driving the

wagon on the crane or displacing the crane itself. The three mechanisms of movement are composed of conical pinions with smooth surfaces, which can at will be made closer or more distant from one another, and which work by friction. The mechanism for removing the crane is nearest to the starting pulley. The two conical pinions *B B* are connected by a sleeve and controlled by one hand wheel, one or other of the pinions *B* being put in contact with the pinion *C*, which is driven in one direction or another, according to which pinion it has been brought in contact with. The displacement of the movable handle is effected by means of one of the hand wheels *Y*, which is worked from the platform *g h* suspended from the crane. This hand wheel is fixed to a rod, the upper end of which is screwed, and which cannot be moved without driving back one of the two springs contained in the boxes *k* and *l*. The pinions are thus forced upon the wheel *C* with a spring pressure, and the movement is gradually brought about by a slowly increased friction. The springs used for the purpose are as follows: Diameter of the steel wire, 8.2 mm.; outer diameter of the spring, 60.2 mm,; number of spirals, 10; height of free spring, 210.5 mm.; initial height of fixed spring, 167 mm.; height of spring completely closed, 153 mm.; initial reaction of spring, 140 kilos.; reaction of spring completely closed, 185 kilos. Under these conditions the movements are easy and continuous, but care must be taken to avoid the pinions being splashed with oil. In order to do so, the backs of all the pinions have been furnished with covers of brass, and screens have been placed between them for their protection. The mechanism for transporting the load is similar to that already described. The mechanism for raising the load differs from the other two in that the pinion B^{11} carried by the principal shaft is collared to a fixed post, while the pinion C^{11}, approaches it by the action of the rod. Further, this rod produces no action except in the direction of raising the load. For in the descent it is sufficient to loosen the brake by pulling the rope *m* when the load is heavy. In a contrary case, the rope *n* must also be pulled, which draws nearer to the pinion B^{11} a pinion *p* carried by the same shaft as the pinion C^{11}, and held generally apart from B^{11} by a buffer spring. The three fly-wheels *Y* and the ropes *m* and *m* are conveniently united in the hand of the conductor, who is placed upon the platform *g h*, and from this elevated position easily follows and conducts the manœuvres below him. In the engraving a system of notched pinions *Z Z* will be observed, and the pulleys for chains *X* placed below the platform *g h*, and commanding the three working rods. This system was invented in order to be able to work the crane from the ground floor of the factory in case of need by means of pendent chains. But experience has proved that it is always best to work it from above on the platform *g h*.

Lifting movement.—The pinion B^{11} governs the ascension movement by means of the smooth pinion C^{11} of the cogged pinion *Q* gearing with the wheel *R*, and of the cogged pinion *S* gearing with the wheel *T*, which is mounted upon the axis of the barrel *U*. The diameters of the governing pulley *A*, of the barrel *U* and of the pinions and intermediary wheels are as follows: Driving pulley *A*, 680 mm.;, smooth pinion B^1, 186.6 mm.; smooth pinion C^1, 280 mm.; cogged pinion *Q*, 63.15 mm., cogged wheel *R*, 1,200 mm.; cogged pinion *S*, 159 mm.; cogged wheel *T*, 1,035 mm.; barrel *U*, 650 mm. The result is that the relation between the course pursued by the cable passing over the pulley *A* and by the load is,

$$\frac{680 \times 280 \times 1200 \times 1035 \times 2}{186.6 \times 63.15 \times 159.2 \times 650} = 388.$$

The shaft on which the pinions *C* and *Q* are keyed carries a counterpoise brake and an automatic tightening brake of the Bourgougnon system, in connection with the hand crane of 8.80 mm. span. The diameter of the pulley of the brake *V* is 360 mm.

Traversing the Wagon J J.—The pinion B^1 causes the traversing of the wagon by means of the smooth pinion C^1 of the cogged pinion *L*, which gears into the wheel *M*, and of the cogged pinion *N*, which gears into the wheel *Q* mounted on the axis of the nut *P*. The diameters of the governing pulley *A*, of the nut *P* and of the pinions and intermediary wheels are as follows: Governing pulley *A*, 680 mm.; smooth pinion B^1, 186 6 mm.; smooth pinion C^1, 280 mm.; cogged pinion *L*, 85.73 mm.; cogged wheel *M*, 700 mm.; cogged pinion *N*, 150 mm.; cogged wheel *O*, 375 mm.; nut *P*, 160 mm. The relation between the course pursued by the cable, passing over the pulley *A*, and by the wagon is:

$$\frac{680 \times 280 \times 700 \times 375}{186.6 \times 85.73 \times 150 \times 160} = 130.2$$

Traversing the crane.—The pinion *B* causes the traverse of the crane by means of the smooth pinion *C* of the cogged pinion *D*, which gears into the conical wheel *E*; of the two pinions *F*, which gear into the two wheels *G*; and of the two pinions *H*, which gear into the two wheels *I*, carried by the axis of the rollers *K*. The diameters of the driving pulley *A*, of the rollers *K*, and of the pinions and intermediary wheels are as follows: Governing pulley *A*, 680 mm.; smooth pulley *B*, 186.6 mm.; smooth pulley *C*, 280 mm.; cogged pinion *D*, 100 mm.; cogged wheel *E*, 300 mm.; cogged pinions *F*, 71.46 mm.; cogged wheels *G*, 250 mm.; cogged pinions *H*, 87 mm.; cogged wheels *I*, 695 mm.; rollers *K*, 650 mm. The relation between the course pursued by the cable, passing over the pulley *A*, and by the crane is:

$$\frac{680 \times 280 \times 300 \times 250 \times 693}{186.6 \times 100 \times 71.46 \times 87 \times 650} = 131.$$

Weight.—The total weight of a crane of the type we have just described is about 10 tons. The load under which these machines have been tested is 6 tons. This is double the normal weight they are called upon to raise in ordinary service. The *Portfeuille Economique des Machines*, from which we gather our information, says they have borne this test in the most satisfactory manner.

The dimension given in the cuts are in meters and millimeters.

The Velocity and Force of a Tornado.

[Abstract of paper read before the American Association for the Advancement of Science, at the New York meeting, by by C. Leo Mees.]

AFTER the tornado at Washington Court House, Ohio, September 16, 1885, it was noticed that in many places in the track of the tornado straws of timothy from 2 to 3 in. long were driven into bark and boards, penetrating to a depth of from 0.05 to 0.10 in. so firmly that they would break off if any attempt were made to pull them out. This could only have been effected by the force of the wind imparting to the straws a sufficient velocity to penetrate these hard substances. This explanation was so unsatisfactory to many, who sought to explain this curious phenomenon by making it depend upon various electrical forces and the like, that the author was led to attempt to produce similar effects by imparting a sufficient velocity to straws by means of an air-current, with the double purpose of proving that the phenomenon could be reproduced in this way, and of determining the minimum wind-velocity which must have been attained.

Hitherto no direct measurements of the velocity of the wind in a tornado had been made. The estimated velocities, ranging from 200 to 600 miles per hour, deduced theoretically from the probable difference in the height of the barometric column in the vortex and in the external atmosphere, must be regarded as merely approximations, because, to our knowledge, there have been no barometric readings ever taken in the vortex of a tornado.

After trial of various methods, it was found that by projecting straws from an air-gun of the air-chamber type, the phenomenon could be perfectly reproduced. A dozen or 20 straws were placed in the barrel of the gun without wad or packing and driven out by a puff of air. The velocity of the straws was directly measured by the method suggested by Professor Mayer for rifle balls in the *Proceedings* of the National Academy. The results were somewhat surprising. A velocity of 130 miles per

hour caused the straws to just stick in the board toward which they were fired. A velocity of 150 miles caused a penetration of about 0.0325 in. (about $\frac{1}{32}$ in.) in pine wood, while at 175 to 180 miles the penetration was 0.05 in. A velocity of 200 miles per hour caused the straws—or nearly all of them—to shatter.

It appears from these results that the minimum velocity of the wind in the tornado was from 140 to 175 miles per hour.

The Engineering Feature of the Nicaragua Ship Canal.

[Abstract of paper read before the American Association for the Advancement of Science, at the New York meeting, by Civil Engineer R. E. Peary, U. S. N.]

THE Nicaragua Canal is known by name, probably, to a majority of persons in this country; but the revised route, the enlarged capacity and the new features presented as the result of the last survey, made two years ago by the United States Government expedition in charge of Civil Engineer Menocal, U. S. N., are not so well known, and of them I will speak. The distance from ocean to ocean by the proposed route is 169.8 miles. Of this distance, however, only 40.3 miles are actual canal, the other 129.5 miles being free navigation through Lake Nicaragua, the Rio San Juan and the valley of the San Francisco. Beginning at the port of Brito on the Pacific side, the canal ascends the valley of the Rio Grande by four locks, and cutting through the low divide enters Lake Nicaragua 17.27 miles from Brito, at an elevation of 110 ft. above the sea. The route then extends across the lake, which is 40 miles wide and over 90 miles long, to its outlet into the Rio San Juan, a distance of 56½ miles. Then down the broad, deep reaches of the majestic San Juan to the dam, 64 miles from the lake. This dam, 1,255 ft. long and 52 ft. high, backs the water of the river the entire distance to the lake and makes it simply an extension of the lake. On the north bank of the river just above the dam, a short section of canal, less than two miles long, cuts through the hills into the Y-shaped valley of the Rio San Francisco lying north of the San Juan and separated from it by a range of hills. An embankment, 6,500 ft. long and 51 ft. high in the center, built across the stem of the Y, floods this valley to the level of the water above the dam and makes about 10 miles of lake navigation. At the eastern end of this lake commences the eastern division of this canal and pierces the divide by a cut 14,200 ft. long and averaging 149 ft. in depth. At the eastern end of this cut is the upper lock of the Atlantic flight, and from here the canal descends the valley of the Deseado by three locks to the sea level, and stretches across the lagoon region back of Greytown to the harbor 11½ miles distant. From the last lock to Greytown, the same as at Brito on the west side, the canal is enlarged, forming an extension of the harbor 11½ miles inland. The lake and the river must form a part of any and every canal route through Nicaragua, and the location as a whole is the result of Civil Engineer Menocal's complete and exhaustive personal knowledge of the entire country from ocean to ocean gained in the course of eight different surveys, extending over a period of 15 years, and supplemented by a conscientious study of all that has been done by others in that region.

Of the 40.3 miles of actual canal, about 27 miles will be excavation pure and simple, while the remaining 13 miles will be largely, if not entirely, excavated by dredges. With the convenient dumping ground for earth excavated, with a large portion of the rock from the summit cut utilized close at hand in the construction of the locks, the dam across the Rio Grande and in pitching the slopes of the canal, and a still larger quantity to be consumed in the construction of the breakwaters at Brito, the work in this section admits of the most economical execution. The divide cut from the basin of the San Francisco to the upper lock, 14,200 ft. in length and with an average depth of 149 ft., is, it is admitted, a very serious job; but with the neighboring streams offering water at a high head for removing the surface earth by hydraulic mining, with a large plant of power drills worked by compressed air, from the same source, and the use of modern explosives to remove the rock, with a large proportion of the excavated rock to be used in the construction of the locks and the dam, and in pitching the slopes of the canal; and a still larger quantity utilized in the construction of the harbors at Greytown; with the laborers above the miasma and mosquitoes of the swamp and exposed to the pure breath of the trade winds, the work can be done without serious difficulty.

There are two features of this project which to many who have not made such structures a study cause a question of safety to arise; one is the dam, which at one stroke gives us 64 miles of river navigation, and the other is the embankment, which at a second stroke gives us over 8 miles of lake navigation and completely solves for that portion of the canal from the dam to the divide (13 miles) the important problem of protection from surface drainage, but neither of them are anything more than small affairs when compared with many others scattered about the world and serving much less important purposes than the ones under consideration, and beside the Quaker Bridge Dam they are pigmies. Right here at the Croton reservoir is a dam which is to-day standing twice the strain that either of them will ever be called upon to resist. The locks are to be magnificent structures of concrete, 850 ft. long, 80 ft. wide and 30 ft. deep, capable of containing any merchant vessel afloat, except the *Great Eastern* and possibly the *City of Rome*. The necessary machinery for moving the locks and culvert gates, for hauling the ships in and out of the locks, for electric lights and other purposes will be worked by hydraulic power furnished by the locks themselves.

In regard to the general question of locks the late Ashbel Welch and the late John G. Stevens are quoted at some length in favor of their use.

Much has been said about the harbors at the termini of the Nicaragua route, and neither time nor space will permit me to enter into the discussion here. It may be said, however, that there is no practical route for a canal across the American Isthmus that has good harbors, and it is believed that those at the termini of the Nicaragua Canal can be made first-class at less cost than those of any other route. There is nothing more difficult in the improvement of Brito Harbor than has been successfully accomplished at numerous French and English breakwater-protected ports and harbors, and the maintenance of the harbor of Greytown will be a much less serious job than is the maintenance of the Port Said entrance of Suez, with the enormous salt discharge of the Nile driven across its mouth by strong littoral currents.

Lake Nicaragua has a surface area of some 2,000 square miles and a drainage area of not less than 8,000 square miles, and the Rio San Juan, its only outlet, discharges at its lowest stage, near the close of the dry season, eight times the maximum supply required by the locks. An inexhaustible supply of the best building material, such as lime, natural cement, stone and timber, can be obtained on the line of the canal, and with an abundance of palm leaves for thatching, such temporary buildings as are required for the accommodation of the working force and the protection of property can be constructed at little more expense than that of handling the material.

At Suez, the traffic has been seriously delayed by the dimensions of the canal and the inadequate number of the turnouts. In the present project, not only have enlarged prisms been provided for, but larger basins are proposed at the extremities of the locks. These basins, the enlargement of the canal at each end, with the lake, the river and the San Francisco basin, will permit vessels to pass each other without delay at almost every point on the route. In 22.37 miles, or 57 per cent., of the canal in excavation the prism is large enough for vessels in transit to pass each other, and of a sectional area in excess of the maximum area in the Suez Canal; the remaining distance in which large vessels cannot conveniently pass each other is so divided that the longest is only 3.67 miles in length; that, with two exceptions, those short reaches of narrow canal are situated between the locks and can be traversed by any vessel in less time than is estimated for the passage

of a lock; consequently, unless a double system of locks be constructed, nothing will be gained by an enlargement of the prisms. In the lake and in the largest portion of the San Juan River vessels can travel almost as fast as at sea. In some sections of the river, and possibly in the basin of the San Francisco, although the channel is at all points deep and of considerable width, the speed may be somewhat checked by reason of the curves.

ESTIMATED TIME OF THROUGH TRANSIT BY STEAMER.

	H.	M.
38.98 miles of canal, at 5 miles an hour	7	48
8.51 miles in the San Francisco basin, 7 miles an hour.	1	14
64.54 miles in the San Juan River, at 8 miles an hour..	8	4
56.50 miles in the lake, at 10 miles an hour	5	39
Time allowed for passing seven locks, at 45 minutes each	5	15
Allow for detention in narrow cuts, etc	2	00
Total time	30	00

The experience of the Suez Canal shows that the actual time of transit is more likely to fall under than to exceed the above estimate. The traffic of the canal is limited by the time required to pass a lock, and on the basis of 45 minutes (above estimated) and allowing but one vessel to each lockage, the number of vessels that can pass through the canal in one day will be 32, or, in one year, 11,680; which, at the average net tonnage of vessels passing the Suez Canal, will give an annual traffic of 20,440,000 tons. This is on the basis that the navigation will not be stopped during the night. The estimate of the total cost of the canal is $64,043,699, which sum includes 25 per cent. for surveys, hospitals, etc., and contingencies. The completion of the canal will require six years, one for final location and five for active work of construction, and the probable traffic for 1892, the possible date of completion of the Nicaragua Canal, is 6,506,214 tons.

Railroads in Turkey.

(From the London *Engineer*.)

FOR a long time past it has seemed as if the mileage of railways within the Ottoman Empire was doomed to remain stationary. It was the more difficult to account for this stagnation, because it was well-known that wherever railroads had been carried out in that empire the district served had experienced very material improvement, and the lines themselves had proved fairly remunerative. There is no country, perhaps, that—to judge from the experience already gained—more demands railroad facilities, or has shown itself to be more appreciative of them, than does the Asiatic territory of Turkey. With the details of the proposed route to India by the Euphrates Valley we are all well acquainted, nor are there many to be found who dispute the arguments upon which its proposers base their advocacy of it. But from a variety of causes this great scheme experiences delay in its realization. We are therefore pleased to learn that, by an imperial Irade (decree) just published in the *Gazette* of Constantinople, privileges have been accorded to British financiers which will enable a first step to be made toward securing the benefits which that route was designed to obtain.

The Irade referred to concedes the privilege of constructing a railroad to Bagdad, and those who have studied the question of providing an alternative route to India through Ottoman territory to the head of the Persian Gulf, will recognize what material aid this concession will afford toward the full ultimate execution of that scheme. A letter from Constantinople assures us that the new line, besides opening up many important and wealthy districts and towns throughout its course, will "bring India closer to England by some four or five days, thus providing a mail route shorter than either the Pacific or the Siberian" Whether it may eventually prove to be desirable that an Indian mail service should be organized by this new route, is a question upon which we do not feel prepared to enter. There may be, and certainly are, many considerations to be given to such a proposal which may not have occurred to the writer of the letter from which we quote; but the fact is incontestible that the advance of railroad communication between Europe and India as far as Bagdad, will revive the hopes of those who deem mail conveyance *via* the Asiatic provinces of Turkey to India to be perfectly feasible. But, apart from the prospect of obtaining a third alternative route to our Indian possessions which the late determination of the Sultan and his advisers has now opened out, we may regard with extreme satisfaction this new enterprise as certain to do much toward relieving the deadlock in prosperity which has so long oppressed the fertile provinces of Asia Minor. These are understood to be among the most productive territories of the world; and yet it is a well-known fact that, year after year, the crops produced in them are allowed to rot upon the ground, owing to the impossibility of conveying them to a profitable market.

The evil this want entails is well illustrated by a single instance given in the letter from which we have above quoted. Its writer informs us that "a sum of not less than £3,000,000 is annually spent abroad in provisioning Constantinople in respect only to three articles of consumption—flour, butter and meat—when Anatolia is well capable of supplying the whole of Turkey in Europe with a large surplus for exportation." We are naturally glad to learn that it is to British enterprise that the removal of so heavy a disability is to be entrusted, the concession having been made to the present lessees of the Haidar-Pasha & Ismid Railroad. Those acting with them contemplate bringing in the line from Haidar-Pasha to Scutari, so as to offer a port at its northern terminus protected from wind and sea at all seasons. This part of the work is to be commenced forthwith. In connection with the whole scheme we learn that a very important decision as to the character to be given to the lines has been arrived at, and this has doubtless been largely based upon the ascertained results to experience of late years in India. The Military Council of the Sultan is said to have strongly advocated their construction upon a narrow gauge; but full survey and inquiry proved that, although this might be cheaper in first cost, mile by mile, than a broad gauge, it would entail, as on the present Adrianople Railroad, the traverse of nearly twice the actual distance to avoid physical difficulties. If to this fact—which is said to have been fully ascertained—be added the considerations as to weight, conveyance, etc., which are now inducing the change in many parts of India of established railroads in that country from the narrow gauge on which they were first constructed to a broader one, we can well approve the determination of the Sultan to face first cost rather than expose the system to consequences which might ultimately cause a large increase upon it.

We may, we believe, see in the concession granted a strong desire on the part of the Government of Turkey to entrust the future of its railway extensions to British enterprise. It is well-known that for a long time foreign influences have been strongly competing in the endeavor to obtain this new opening for other nationalities. We have, of course, nothing to say on the political aspect of the Sultan's act. We may feel assured that, even before the new railroad reaches its terminus at Bagdad, British *entrepreneurs* will be active, with the object of extending it further toward the Persian Gulf. The route to India, therefore, that has so long been advocated, will probably by this independent concession find advancement from a quarter from which but little help was to have been expected. It may not fulfil all the desires of those who have struggled so persistently toward the realization of their designs, but it must contribute greatly toward ultimately obtaining the fulfilment of them.

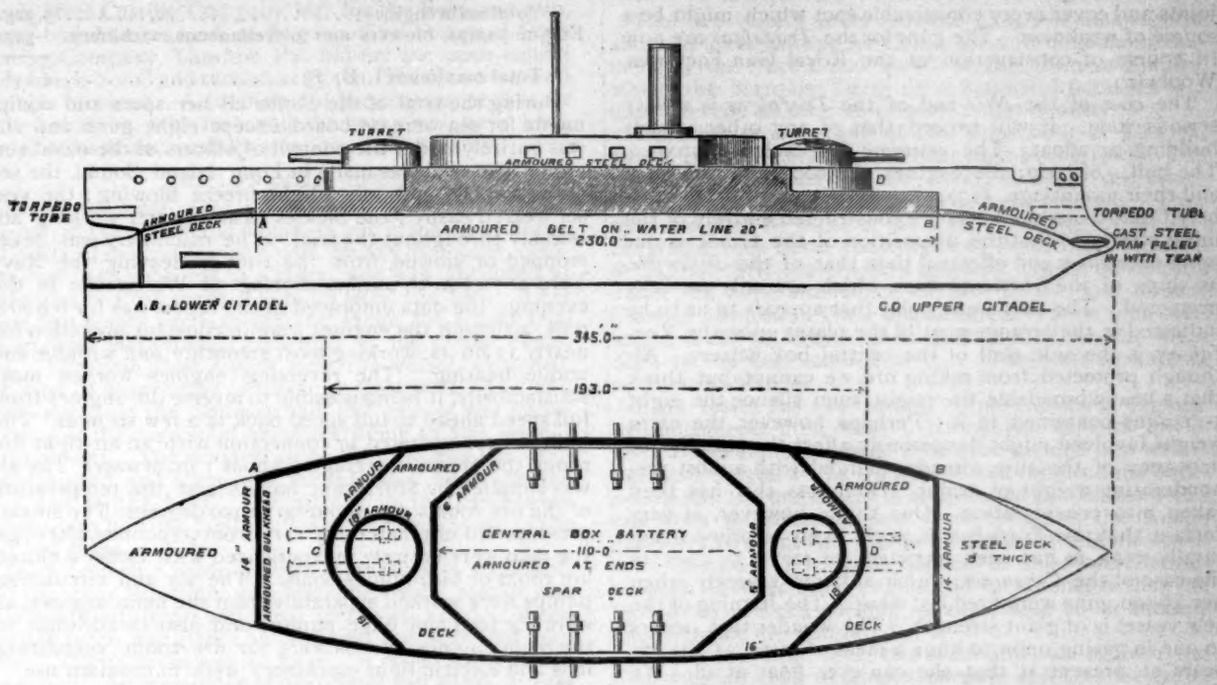
The English War-Ship "Trafalgar."

(From the London *Engineer*.)

THE most powerful iron-clad afloat, so far as regards her thickness and weight of armor and displacement, H. M. S. *Trafalgar*, will be launched from Portsmouth Dockyard about September 20. The work of completing the vessel so as to be in readiness for this event is progressing with the utmost rapidity, and proceeds night and day un-

interruptedly, the hull being lighted throughout with electric lamps. This illumination is rendered necessary even at midday, as the ramification of water-tight compartments darkens the lowermost recesses of the ship completely. There are 27 entire bulkheads dividing the interior space into so many separate portions, and the decks again sub-divide these almost indefinitely. The

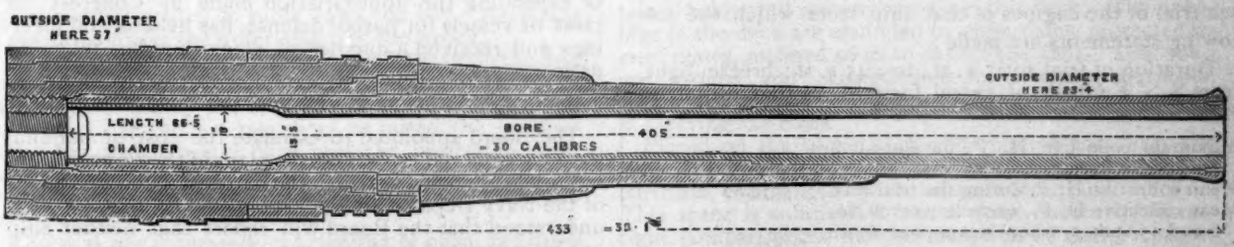
Those on the sides taper, or are beveled off beneath the water-line to an edge of only 8 in. The teak is dressed and cut away on the surface so as to fit the plates precisely. The plates at the ends of the main citadel are secured by the bolts being passed through large holes left at intervals in the bed of the turret, otherwise they could not be worked in. Over the whole of the main or upper



THE ENGLISH IRONCLAD SHIP "TRAFALGAR."

accompanying illustration, which gives merely an approximate idea of this vast fighting machine, and is designed only to show the position of the several citadels, 3-in. steel decks and armored bulkheads, should be studied in order to understand the modifications which have been made in the two iron-clads of most recent type —the *Nile*, now building at Pembroke, and the *Trafalgar*, which is the subject of the present paper, they being sister ships. The dimensions are: Length, 345 ft.; breadth, 73 ft.; displacement, 11,940 tons; indicated H. P., 12,000; draft, 27 ft. 6 in. The armor belt at

citadel is a 3-in. steel deck; upon this is built a central-box battery for eight 5-in. breech-loading guns. The side walls of this are of light plates, but the ends are protected from raking fire by 6-in. armor and a backing of teak. Upon the spar deck covering this battery the boats will be stowed, and a number of machine guns and quick-firing guns will be mounted, the latter comprising eight 6-pounder Hotchkiss, and eleven 3-pounders of the same nature. The ends of the vessel are protected beneath the water-line by a steel deck 3 in. thick, extending from the 14-in. bulkheads before alluded to to the ram at one end



SECTION OF THE ENGLISH 67-TON BREECH-LOADING GUN.

the water line extends to a length of 230 ft. amidships, and is 20 in. thick at the center, tapering off slightly to the ends, where it encounters and combines with bulkheads of 14-in. armor, thus forming with them a sort of lower citadel, this being decked over with 3-in. steel so far as the ends of the main or upper citadel. The same 20-in. plates that form the walls of this lower portion are continued upward as the walls of the upper citadel, which is 193 ft. in length, but the thickness of the plates is reduced to 16 in. The parabolic ends or bulkheads of the upper citadel are protected with 18-in. armor, as are also the turrets which spring from within its angles. The armor, both of sides and bulkheads, is backed with about 18 in. to 20 in. of teak, and behind this again is a strong inner steel skin 2 in. thick. The plates are compound, having wrought-iron backs with a steel face.

and to the sternpost at the other. Thus the vitals of the ship are completely protected by armor plates from end to end. The number of torpedo tubes will, we understand, be four, one in the bows, one astern and two diagonally from the broadside. The turrets will be revolved by hydraulic power.

Each turret will contain two 67-ton breech-loading steel guns, which will also be loaded and worked by hydraulic power, being on the disappearing system, hinged upon huge levers, which rise for firing within rectangular slots, and descend for the loading position beneath the armored deck. A section of one of the turret guns appears in an illustration. Its dimensions are as follows, they being a striking contrast to those of the 81-ton muzzle-loading guns of the *Inflexible*, the proportions being so singularly slender, and the length so very remarkable: Total length,

36 ft. 1 in, (433 in.); length of bore, 405 in.; diameter of bore of gun, 13.5 in.; diameter of powder chamber, 18 in.; length of powder chamber, 66.5 in.; capacity of powder chamber, 17,100 cubic inches; weight of gun, 67 tons: full charge, 520 lbs. prismatic brown powder; estimated muzzle velocity, 1,960 foot-seconds. It is entirely of forged steel, and the disposition of the breech-piece and of the covering hoops have been designed so as to break joints and cover every conceivable spot which might be a source of weakness. The guns for the *Trafalgar* are now in course of construction at the Royal Gun Factories, Woolwich.

The cost of the *Nile* and of the *Trafalgar* is a very serious item. It will exceed that of any other vessels building or afloat. The estimate for each is £920,000. The hull, £686,000; the engines, £97,000; and the guns and their mountings, £137,000. But it must be remembered that these two ships are constructed entirely of the finest steel, and that the disposition of the armor is far more extensive and effectual than that of the *Inflexible*, or ships of the *Admiral* class, which are only partially protected. The only weak point that appears to us to be indicated in the arrangement of the plates upon the *Trafalgar*, is the side wall of the central box battery. Although protected from raking fire, we cannot but think that a heavy broadside fire might soon silence the eight 5-in. guns contained in it. Perhaps, however, the extra weight involved might dangerously affect the stability or buoyancy of the ship, already charged with a most preponderating weight of armor. Doubtless this has been taken into consideration. One thing, however, is very certain, that the *Trafalgar* is never likely to prove structurally weak, as has been reported, we regret to learn, in the case of the *Conqueror*, which suffered severely when her 45-ton guns were fired last week. The framing of the new vessel is of giant strength. The wonder that occurs to one in gazing upon so huge a mass of metal as she appears at present is that she can ever float at all. We should have mentioned that the important steering gear and engines which work it, are well down near the sternpost and below the protecting steel 3-in. deck. The coal is, as in the case of the *Imperieuse* and later ships, so disposed as to add an increment of strength to the armor, being spread beneath the decks in extended bunkers.

THE NEW WAR SHIPS.

THE report of Captain F. M. Ramsay, U. S. N., commanding the new cruiser *Boston*, gives particulars of the sea trial of the engines of that ship, from which the following statements are made:

Duration of trial 10:45 A. M., to 4:45 P. M.; breeze light, from S. S. E.; draft of vessel forward, 14 ft. 9 in.; aft, 19 ft. 2 in.

Maximum collective H. P. developed by machinery during the trial was	4248.50 I. H. P.
Mean collective H. P. during the trial was	3779.82 "
Mean collective H. P., excluding cards Nos. 6 and 13, taken when steam was down, was	3888.20 "
Coal burned per square foot of grate surface	35.43 lbs.
Mean air pressure, forward fire-room	0.985 in.
After fire-room	1.008 "
Maximum I. H. P. per square foot of grate	12.75 "
Mean distance run per hour	13.8 knots.
Mean revolutions	68.35
Mean steam pressure	86. lbs.

The engines worked smoothly, without jar, and perfectly cool, with the exception of two main journals which warmed slightly. After low-pressure crank-pin heated slightly, due to the telescopic oiling tube carrying away before trial began. During later part of trial a higher number of revolutions was made, due probably to decrease of friction of the higher parts.

The *Boston* has not been docked since September 6, 1886, and the comparatively low speed, compared with the *Atlanta*, is due to foul bottom. The trial was continuous, no stop; and the boilers did not foam.

The maximum indicated horse-power shown above was made up as follows:

High-pressure cylinder	1,561.6
Forward low-pressure cylinder	1,102.9
After low-pressure cylinder	1,259.0
Total main engines	3,923.5
Engine pumps, blowers and miscellaneous machinery.	325.0
Total maximum I. H. P.	4,248.0

During the trial of the *Boston* all her spars and equipments for sea were on board, except eight guns, and she was entirely under the control of officers of the naval service. The trial was made in Long Island Sound, the sea being smooth and only a light breeze blowing; the vessel steered easily; the Sickles steam steerer working admirably throughout the trial. The machinery was never stopped or slowed from the time of leaving the Navy Yard at 7:15 A. M. until anchoring off Whitestone in the evening; the data embraced in the report was for 6 hours only, although the engines were in constant operation for nearly 12 hours, working most smoothly and without any undue heating. The reversing engines worked most satisfactorily, it being possible to reverse the engines from full speed ahead to full speed back in a few seconds. The boilers were operated in connection with an air-tight fire room, the pressure averaging about 1 in. of water The air was supplied by Sturtevant boilers and the temperature of the fire rooms was about 90 to 100 degrees. The steam-pressure did not materially vary from 90 pounds, although the men were entirely inexperienced with either a closed fire room or bituminous coals. The air and circulating pumps were worked separately from the main engines, as were the feed and bilge pumps, and also in addition to the main engines, the blowers for fire room, ventilating fans and electric-light machinery were in constant use.

The main engines, it is believed, will develop 4,000 H. P., when the firemen are well trained in their work. The fuel used was New River (West Virginia) coal.

The engines of the *Chicago* have had the usual preliminary dock trials, the results of which have not yet been officially reported.

VESSELS FOR HARBOR DEFENSE.

Work has begun on the completion of the double-turreted monitor *Miantonomoh* at the Brooklyn Navy Yard. It is said that there will be no cessation of work until the ship is ready for service.

The Board to consider the question of the best method of expending the appropriation made by Congress for rams or vessels for harbor defense, has held several meetings and received a number of plans, but has taken no action as yet.

OTHER NEW VESSELS AND GUNS.

The Board appointed to estimate the cost of building the new armored cruiser on the plans of the Barrow Shipbuilding Company, and also the battle-ship on the plans of the Navy Department, has submitted its report. It is understood that the Board will report that neither ship can be completed for $2,000,000, the amount appropriated by Congress. Further action on the part of that body may therefore be needed.

It is said that the armored cruiser will be built at the New York (Brooklyn) Navy Yard and the battle-ship at the Norfolk Yard.

The schedule of new tools needed at the New York and Norfolk yards has been made up, and bids will soon be called for.

Active work is going on in equipping and preparing the new shops at the Washington Navy Yard for the assembling and finishing of steel guns of large size. The machinery includes very heavy lathes and also heavy cranes for handling the large guns and heavy masses of steel.

The 94 Hotchkiss guns ordered by the Navy Department are being built by the Pratt & Whitney Company in Hartford, Conn., under the supervision of Mr. E. W. Very, Agent of the Hotchkiss Company.

At the Navy Department, September 20, proposals were opened for cast-steel guns. These were the bids received under the advertisement of the Secretary, of June 23, extended July 20. This called for proposals "for the purchase and completion of three steel-cast, rough-bored and turned, 6-inch, high-power rifle cannon of domestic manufacture, one of which shall be of Bessemer steel, one of open-hearth steel and one of crucible steel." The Pittsburgh Steel Casting Company bid for the Bessemer gun, rough-bored and turned, at $3,300. The Standard Steel Casting Company, Thurlow, Pa., bid for the open-hearth gun, rough-bored and turned, at $5,300. These two were all the bids received. A condition of the contract is that no casting shall be paid for until the gun shall have been completed and successfully stood the statutory test.

THE DYNAMITE GUN.

A trial was made, Sept. 15, at Fort Lafayette, New York Harbor, of the pneumatic dynamite gun invented by Lieut. Zalinski. The condemned Coast Survey schooner *Silliman* had been procured as a target and was anchored at a distance of 1,980 yards (1⅛ mile) from the fort. After firing two empty shells to get the range, the actual trial began, with shells loaded each with 55 lbs. of the explosive. The first shell struck near the vessel, exploded, and a jet of water arose in the air at least 60 ft. As it fell, it was seen that the *Silliman* had lost one of her masts, a stump of the once solid wood testifying to the vessel's bereavement. The wood-work of the *Silliman* was seriously injured, and there was considerable water on the deck and in the hold. The fittings in the cabin were thrown into horrible confusion, and the beginning of the end had come.

The fourth shot made a terrific noise as it exploded, and the spray this time was blackened with smoke and interlarded with spars and small pieces of wood. When this had fallen, one glance showed that the work had been done. The *Silliman* was no more. A mast stuck up in the water; the remainder of the vessel had sunk. Pieces floated around everywhere. The projectile struck directly under the middle of the hull and lifted it bodily from the water. The *Silliman's* water tank was carried from the hold up through the deck and rested on the top of the wreckage. The stump of the mainmast directly in front of it was smashed completely.

The trial was concluded by firing two more shots. The fifth shot struck the wreckage that was sticking up in the water and cleared away a large amount of débris, making a loud noise. The sixth shot was simply to show that the projectile could hit exactly the same spot it had previously touched. It would have struck the *Silliman* in the same place that the third shot struck if the ruined vessel had not drifted 20 yards down the bay. As it was it exploded under the water astern of the wreck.

The air pressure used by Lieutenant Zalinski in the first four shots was 600 lbs., but, though they were successful in their work, they fell slightly short of what he had calculated. In the last two shots he raised the pressure to 607 lbs., which would have sent the projectiles right into the center of the vessel. Every one of the projectiles would have landed on the deck of any ordinary sized vessel.

The trial was witnessed by a number of naval and army officers and some other invited guests. Three Zalinski guns will be mounted on a gunboat now building in Philadelphia, for which a special appropriation was made.

OLD SHIPS CONDEMNED.

The old war-ship *Tennessee* was sold at auction at the New York Yard, September 15, and brought $34,425. She is to be cut down and end her days usefully, if ingloriously, as a coal barge on Long Island Sound. When built in 1865, just at the close of the war, the *Tennessee* was known as the *Madawaska*. She made a short trip under that name to the West Indies, after which she took her present title. She is of 3,200 tonnage and carried a battery of sixteen 9-in. smooth-bore guns, four 8-in. breech-loading rifles and one 11-in. rifle gun.

Her first long cruise abroad was as flagship of the East India squadron. But for the greater part of her commissioned life the *Tennessee* served as flagship of the North Atlantic Squadron, having carried the pennants of Rear Admirals Wyman, Cooper, Jouett and Luce.

The Chinese Navy.

(From the London *Times*.)

THE five vessels under Admiral Lang's command, now about to leave Europe for China, are a formidable installment of the "bolts and bars" of the Chinese Empire, which the Marquis Tsêng on a historical occasion said must precede all internal reform in that country.

The fleet is composed of two ships built at Elswick, two at Stettin and a torpedo boat built by Yarrows. The two English vessels are the *Chih Yüan* and the *Ching Yüan*, and are of the swift protected cruiser class. They were designed by order of the Marquis Tsêng, by Mr. W. H. White, then naval constructor to Armstrong, Mitchell & Co., but their construction has been carried out mainly under the superintendence of Liu Ta-jên, the present Chinese Minister. Their displacement is 2,300 tons; the length is 268 ft., breath 38 ft. and depth from the main deck to the keel molded 21 ft. The draft forward is 14 ft., and aft 16 ft.

Each vessel has two pairs of triple-expansion engines, by the eminent firm, Messrs. Humphrys, Tennant & Co. Both the engine and boiler rooms are divided into watertight compartments by transverse and longitudinal bulkheads, and the machinery is so arranged that either boiler can work on either engine or on both, and the change necessary to effect this can be carried out while the vessel is in motion. The consequence of this intercommunication between each engine and each boiler is that the vessel can proceed so long as any single boiler and any single engine are uninjured.

In the four trial trips, two with and two against the tide, with all their weights, armament and Chinese crews on board, they attained an average speed of 18.536 knots.

The crews, it should be mentioned, have been lying in Newcastle for the past two months or more, and their orderly conduct has been the subject of encomium. They seem smart, sailorlike and well cared for, and they apparently have the sailor's capacity of finding friends everywhere.

The material of the vessels is steel; there are two decks, the lower one being of the turtle-back description, and consisting of 4-in. steel plates, rising in the middle above the waterline and inclined at the sides so as to dip some feet below it. The engines, magazines, rudderhead, steering gear and all the important parts of the vessel are contained below and are protected by this deck. The openings in the deck are encircled by cofferdams, protected by steel plates, inclined so as to deflect the shot. The bows are formed and strengthened for ramming purposes. Additional protection is given to the vessel by the method of carrying the coals.

Placed on the turtle deck and running parallel to the sides of the vessel for the greater part of its length is a partition, enclosing a space between itself and the side. This space is subdivided into a great number of watertight compartments for the reception of coal or patent fuel. An additional protection of a layer of coal about 8 ft. in thickness all round is thus given to the vessels. The bunker accommodation is 450 tons. Both ships have double bottoms, which it is unusual to find in vessels of this size, although their advantages to all ships, and more especially to war vessels, are obvious. The space between the two bottoms is divided into numerous watertight compartments.

The armament consists of three 21-centimeter Krupp guns, two 6-in. Armstrongs, eight 6-pounder, rapid-firing Hotchkiss guns and six Gatlings. Of the Krupps two, which are placed in the bows, are mounted on Vavasseur carriages, on revolving platforms, protected by splinter-proof shields, and one, which is in the stern, is also placed on a Vavasseur carriage, revolving on a center pivot. In both cases the guns are moved by means of hydraulic machinery. The Armstrongs likewise move on center-

pivot Vavasseur carriages, and are placed on sponsons at the side of the vessel so as to allow of the training of the guns over a very large arc, about 160 degrees. These likewise are protected by 2-in. steel-plate splinter-proof shields.

The torpedo armament consists of four above-water torpedo guns—one fixed in the bow, firing right ahead, one right astern, and two training guns are fixed in each broadside forward.

There are two electric search lights for each vessel, of a nominal power of 25,000 candles, while the cabins and rest of the ship are lighted with incandescent lamps.

Each has two mainmasts, with military tops, four yards, fore and aft sails. Each has likewise a conning tower of 3-in. steel plates, from which the working of the ship's guns and torpedoes can be directed. An important addition is an armor-plated tower for the protection of the signalman, which was suggested by Admiral Lang.

The guns are provided with converging fire apparatus, so that they can be fired singly or simultaneously. The steering gear is hand and hydraulic. The equipment is exceedingly ample in every respect and has rarely, if ever, been equalled by that of any ship built in this country. Lord Armstrong and Captain Noble have put out all their energies in their respective spheres to make these vessels perfect as far as human skill and labor can perfect them.

The torpedo boat, as has been mentioned, was built by Yarrows, under a contract with Messrs. John Birch & Co., of Liverpool, and it is said to be the fastest of its size that has ever been launched. It has reached the great speed of about 28 miles an hour. It is armed with two fixed 14-in. torpedo guns in the bows and one 14-in. training gun on deck, abaft the funnel. It is also supplied with a powerful armament of Hotchkiss and Gatling guns and a strong electric light so arranged as to be worked either from the conning tower or from the deck, where it can be moved from side to side by means of rails. The light is also interchangeable in the conning tower with a Hotchkiss gun.

The two vessels built in Stettin by the Vulcan Shipbuilding Company, are of the class of armored cruisers. Their speed is under 16 knots. They are armed with two 21-centimeter Krupp guns in the bows, mounted *en barbette* and encircled by an armor-plated breastwork. These have also two 6-in. Krupps, so that, although larger than the Armstrong vessels, they have one 21-centimeter Krupp gun less than the latter. Their names are the *King Yüan* and the *Lai Yüan*, and their details were frequently altered during the course of construction.

This squadron of two armored cruisers, two swift protected cruisers and a torpedo boat is commanded by Admiral Lang, the officer to whom the Chinese Navy is indebted for the greater part of the efficiency it possesses. As he is an officer of the Royal Navy, in which he holds the rank of Captain, he is lent by the Admiralty to the Chinese Government, and nothing could demonstrate more clearly the desire of the British Government that China should have a strong and efficient navy than the loan of an officer so able, energetic and intelligent. Admiral Lang's value is well-known to the Chinese, and especially to Li Hung Chang, for, when he thought it his duty to resign his post on the outbreak of the Franco-Chinese war, and his place was taken by a German officer, he was welcomed back with open arms on the conlusion of peace.

Several retired officers of the Royal Navy have been employed to aid in navigating the squadron out to China, but each vessel is commanded by a Chinese officer who has passed through the Naval College at Greenwich and has served in one of Her Majesty's iron-clads. It should be added that the completeness of the armament and equipment of the squadron is largely due to the support and co-operation which the Ministers in London and Berlin received from Li Hung Chang, who, in his capacity of Vice-President and principal practical head of the new Board of Admiralty in Pekin, had naturally a preponderating influence in all questions connected with the expenditure on the ships.

Electric Light for the New Cruisers.

[Paper read before the National Electric Light Association by Lieutenant J. B. Murdock, U. S. N.]

THE question of how to best install the electric lights in the new men-of-war has been considered in detail, and it seemed advisable to bring the matter before the National Electric Light Association, that the manufacturers of the country might have the problem presented to their consideration in advance of the time when they would be asked to act upon it. In conversation with managers of various companies, it has been impressed on my mind that the peculiar conditions existing on shipboard are but imperfectly understood, and as a natural consequence they have not as yet been as satisfactorily met in this country as abroad. I am confident that American ingenuity and skill can fully meet our requirements, and hope that the number of dynamos, about 60, which will be needed for the vessels already authorized by Congress, may be considered as meriting the experiments necessary for their successful installation.

I am authorized to present in a general way the views of the Bureau of Ordnance of the Navy Department on the peculiar conditions to be met, and on the best method of meeting them.

In men-of-war the prime requirements of all kinds of apparatus are compactness and lightness. Neither of these is of any material consequence in electric-light installations on shore, and both are generally ignored. Attention has there been given mainly to the question of efficiency of conversion, and a glance at the advertising columns of any of the electrical journals shows that the maximum efficiency and best system of electric lighting is possessed by each of a dozen companies. Our conditions, so far as the dynamo is concerned, may be summarized as wishing the greatest electrical output for a given weight and bulk, and although at first thought this may seem to be essentially the same thing as efficiency of conversion, it is widely different.

The following figures of well-known American dynamos illustrate this point. The comparison is made on the basis of "watts of output per pound of dynamo." The weight, speed and electrical output have been obtained in general from the manufacturers, and are given, of course, only approximately. In this comparison it is, of course, necessary to consider also the sizes and the number of revolutions, the watts per pound increasing with large machines and high velocities. (Table I):

TABLE I.

DYNAMO.	Revolutions.	Watts in external circuit.	Watts per pound.
Edison, No. 20	800	50,000	6.0
Brush, H. 3	850	66,000	9.4
American, 50-Light	875	21,600	5.7
Westinghouse, No. 18	900	30,000	5.4
Hochhausen, No. 8	1,000	35,200	8.8
Mather, 500 Lights	1,050	35,250	7.4
Weston, 6 W. I	1,050	11,500	4.1
Brush, G. 4	1,050	28,300	9.3
American, 16-Light, Hie	1,075	6,480	4.8
Weston, 7 W. I	11,000	20,125	6.5
Westinghouse, No. 12	11,000	18,000	4.0
Brush, F. 5	11,000	19,000	8.5
Thomson-Houston, H. I	11,500	25,600	6.1
Edison, No. 12	12,500	30,000	6.9
Hochhausen, No. 6	12,000	17,600	8.0
Thomson-Houston, E. I.	12,500	13,200	5.8
Mather, 400 Lights	13,000	28,100	7.0
Edison, No. 8	14,000	20,000	6.9
Thomson-Houston, C. I	15,000	6,000	5.6

The next consideration is that of the connection of the dynamo to its engine. A starting point is afforded in the rule that belting should never be used on a sea-going vessel. Nothing so radically violates our condition of economy of space as the use of belting. When space is saved by the use of a short belt, the working conditions are comparatively unsatisfactory. Belts are liable to be thrown off by the sudden change of load to which our dynamos are subject, and become a source of danger to the attendants if the ship is rolling heavily. The adoption of friction gearing between engine and dynamos has been

suggested, and is probably practicable, but its durability on shipboard, when the motion of the vessel must cause working of the two shafts, may not be great. In the navies of Europe, the practice of direct connection is universal, the dynamo shaft being coupled to that of the engine. This calls, of course, for either a great reduction of the speed of the dynamo, or a corresponding increase of that of the engine. It is easy enough to procure an engine running 1,500 revolutions per minute, but it is a very different matter to find one which will govern satisfactorily at so high a speed. So far as I can ascertain there is no automatic engine manufactured in the United States capable of indicating 30 H. P. which is designed for a higher speed than 400. I have been informed, however, that some of the type now in the market could be modified so as to operate well at 500. I am not aware of any dynamo in the United States absorbing 30 H. P. which would yield its normal output at even the higher speed. It is much easier to reduce the speed of the dynamo, while preserving its electrical output, than to raise the speed of the engine. Admitting the desirability of direct connection on shipboard, the problem proposed is the best method of obtaining the same output, in watts per pound, at speeds below 500, that are now commonly obtained between 1,000 and 1,500.

The following figures of European dynamos, obtained in the same way as those already given for American machines and probably equally accurate, will show how this problem has been met abroad. (Table II):

TABLE II.

DYNAMO.	Revolutions.	Watts in external circuit.	Watts per pound.
Manchester, No. 6	350	9,000	3.6
Victoria, H. 3	350	36,000	9.7
Siemens & Halske	350	16,000	8.1
Edison-Hopkinson, 10 in L	350	16,800	2.9
Manchester, No. 7	400	22,500	4.6
Victoria, F. 3	400	21,600	8.6
Siemens & Halske	400	20,000	10.2
Edison-Hopkinson, 15 in S	420	39,600	3.4
Gramme, H. 2d 255	450	23,600	8.3
Elwell-Parker	450	50,000	5.6
Crompton, $\frac{40}{110}$ J	460	45,100	6.7
Edison-Hopkinson, 8 in L	525	15,400	3.3
Manchester, No. 5	525	6,500	4.7
Crompton, $\frac{22}{110}$ J	550	24,750	6.0
Manchester, No. 6 A	550	25,000	6.75
Edison-Hopkinson, 10 in L	550	25,200	4.4
Victoria, D 2 S	600	8,400	6.7
Gramme, H. I. c 200	600	14,000	6.4
Ganz	670	50,400	9.2
Crompton, $\frac{60}{110}$ J	675	66,000	9.8
Goolden-Trotter	765	16,000	7.2

It is necessary to only refer incidentally to a few of the methods by which these results have been obtained. The principal are the elimination of all iron not needed for the magnetic circuit of the dynamo, and the adoption of a type in which the circuit furnishes a framework of necessary rigidity. The magnet core should be of the best wrought-iron, this single condition frequently reducing the weight 25 per cent., while preserving the output. Armatures of large diameter give high peripheral velocity at low speed, and this seems to recommend the Gramme ring, a large drum armature being cumbersome. The Gramme form has another advantage for ships' use, that it can be repaired or even re-wound with the facilities existing on shipboard, although I believe a Siemens winding has recently been perfected which admits of equal facility of repairs. The use of multipolar machines contributes to lightness, and the Siemens & Halske machine referred to in the preceding table has four field magnets inside a Gramme ring. Flattened ring armatures and multipolar magnets also give large output for the weight.

Every ship, aboard which the electric light is a necessity, should have two similar dynamos, that either may be used at will. At present, this precaution is not observed in the Navy. The lighting of the ships by incandescent lamps is under the control of the Bureau of Navigation, and the installation for this purpose consists of an ordinary plant of an engine driving a dynamo by belting. The electric search lights, two of which are furnished to each large vessel, are supplied by the Bureau of Ordnance, the installation for this purpose consisting of a Brotherhood engine driving two "C" Grammes connected direct on the same bed-plate. In case of accident, the incandescent dynamo will not work the search lights to advantage, nor will the Grammes operate the incandescent lights well. This is, of course, most unsatisfactory, and the need of the service is for a dynamo which will perform either work well, and, if necessary, both at once. Our search lights require about 50 volts and 50 ampères for ordinary work, the current being sometimes increased to 100. The lamp is operated by hand in order to fully utilize the radiation from the crater of the positive carbon. The hand lamp and Mangin projector are in use in nearly every navy in the world, for projecting a condensed beam of light to a distance. Automatic lamps do not admit of continuous adjustments as readily as the hand lamp, and are not so thoroughly under the control of the operator. In any search lights the arc may sometimes fail, and it is sometimes advisable to cut the lights out without notice. Large and sudden variations of load are thus liable to occur, and these should not affect the dynamo. It is unquestionable that incandescent lights can be worked from a series dynamo, and search lights operated by a shunt machine, but most of these proceedings are makeshifts. It is undeniable that both search lights and incandescent lights can be worked satisfactorily by a compound dynamo. I have been called upon to work all these kinds of dynamos for each purpose, and the compound dynamo works incandescent lights as well as the shunt machine and search lights better than does the series machine applied for the purpose. I have also worked 2 search lights and 50 incandescent lights simultaneously from one compound dynamo. Each search light had three tenths of an ohm dead resistance in circuit to bring the difference of potential down to about 50 volts. There is nothing new in this, but I have so frequently been asked what advantage the compound dynamo possessed, that I have trespassed somewhat on the time of the Convention to give reasons for the opinion that all naval dynamos should be compound wound for a constant potential.

It is probable that many fine new vessels will require electric motors. Some of our gun carriages may be worked in this way, on account of the advantages that an electric motor offers in small weight and bulk, and in the important fact that it is so much easier to splice a broken main than to patch a leaky pipe when steam or compressed air is used for power. Electric motors will be useful for shell hoists and ammunition whips, reducing the number of men employed for these purposes. Here, also, light weight and compactness are absolutely essential, and nine tenths of the motors in commercial use would be barred out as too heavy. A 10 H. P. motor, the largest we would probably use, should not weigh over 500 lbs.

The potential at which the main should be kept must be determined from the relative importance of the three uses to which our dynamos will be put. As we are not bothered by the question of long-distance transmission, we can well use a low potential for incandescent lights and motors, while search lights require only 50 volts, although it is advantageous with any dynamo to have a little dead resistance in the search-light circuit. For these reasons I think 70 volts is about the best point for a compromise. This is the voltage used in the French Navy, the English working at 80. If two search lights can be successfully worked in series, the potential at the dynamo might advantageously be raised to 110 or even 120 volts. Experiments have been made to test this point, but it is not decided as yet. Should there, however, be any material advantages secured in the working of either incandescent lights or motors by the use of a high potential, the search lights could be operated with sufficient resistance to give them their proper potential.

The same requirements of small bulk and weight must control in the choice of engines. The adoption of a compound dynamo throws extra responsibility on the engine, as without constant speed the advantages of the dynamo are not apparent. American automatic engines can easily

meet this demand, but most of them are too heavy, rigidity of frame being secured by the use of unnecessarily large masses of cast-iron. One hundred pounds weight per I. H. P., with 80 lbs. steam, is a liberal allowance. In many European engines steel and phosphor-bronze have been largely used to obtain lightness.

It may be interesting to compare a few well-known dynamos as to compactness, the comparison being made watts of output per square inch of floor-space. (Table III):

TABLE III.

DYNAMO.	Revolutions.	Watts in external circuit.	Watts per sq. inch floor-space.
Manchester, No. 6	350	9,000	4.9
Edison-Hopkinson, 10 in L	350	16,800	6.9
Manchester, No. 7	400	22,500	6.0
Edison-Hopkinson, 15 in S	420	39,600	9.1
Crompton, $\frac{40}{110}$ J	460	45,100	20.3
Edison-Hopkinson, 8 in L	525	15,400	6.5
Manchester, No. 5	525	6,500	4.6
Ganz	670	50,400	20.9
Crompton, $\frac{60}{110}$ J	675	66,000	26.4
Edison, No. 20	800	50,000	8.8
Brush, H^2	850	66,000	23.5
Westinghouse, No. 18	900	30,000	5.8
Hochhausen, No. 8	1,000	35,200	15.0
Mather, 500 Lt	1,050	35,250	8.5
Weston, 6 W. I	1,050	11,500	4.4
Brush, G^4	1,050	28,300	17.7
Weston, 7 W. I	1,100	20,125	5.4
Westinghouse, No. 12	1,100	18,000	4.7
Brush, F. 5	1,100	19,000	15.3
Thomson-Houston, E. I	1,150	25,600	9.0
Edison, No. 12	1,200	30,000	7.7
Hochhausen, No. 6	1,200	17,600	13.3
Thomson-Houston, E. I	1 250	13,200	8.2
Mather, 400-Light	1,300	28,100	7.3
Edison, No. 8	1,400	20,000	6.0
Thomson-Houston, C. I	1,500	6,000	5.9

The preceding show a general average of about 40 lbs. dead weight of dynamo and engine for each 16-candle lamp, whether high or low-speed dynamos are used. In the following tables special attention has been paid to the manufacture of light and compact apparatus.

As illustrating the advantages of direct connection in economy of floor-space and also of weight when care is taken, I give a few statistics of ship installations in Tables IV and V (these tables will be found below, on this page).

It is noticeable abroad that, with the type of slow-speed dynamos established in the markets, the system of direct connection is adopted in many isolated plants on shore. The tendency throughout Europe is to reduce the speed of dynamos, preserving the electrical output by a careful study of details. Few recent machines built abroad are designed for higher speeds than 800, while an American company operating at and above 850 advertises slow speed as one of the advantages of its dynamos.

In this country the naval demand for slow-speed dynamos will be comparatively small, but if it serves to introduce the type into the market, I am satisfied from what has taken place in Europe that the system of direct connection will create a field for itself, as soon as the apparatus can be procured without the heavy expense attendant on special work. It recommends itself in any installation where either weight or floor-space is to be economized. I believe it can be successfully used and utilized in lighting railroad trains, especially if, in the near future, railroad companies have to furnish steam for heating purposes. Plants could be furnished small steamers and yachts, in which a common installation could not find room.

There are one or two other considerations governing ships' installations. The principal one is the absolute necessity of high insulation. The Bureau of Navigation has, in its recent contracts, called for an insulation-resistance of 1,000 megohms per nautical mile, after 24 hours' immersion in salt water.

TABLE IV.

	PLANT.	Connection.	Total weight.	Floor-space.	Weight per 16c. lamps.	Sq. in. of floor-space per 16c. lamps.
	1 200 light Brush compound 1 8-in. Brotherhood	Direct.	5,500		27½	
Steam yacht *Restless.*	1 Arnold dynamo (30 lights) 1 Vertical engine	Friction.	600	6 sq. ft.	20	29
	1 Goolden-Trotter dynamo (75 lights) 1 Tower engine	Direct.	900	5¼	12	11
	1 Victoria dynamo (60 lights) 1 Brotherhood	Direct. 765 Revs.	800	$4\frac{11}{16}$	13	11
Italian cruiser *Dugali.*	1 Parson's dynamo (150 lights) 1 Parson's steam turbine (3 plants like above.)	Direct. 9,000 Revs.	500	6¼	6	6

TABLE V.

	PLANT.	Connection.	Total weight.	Floor-space.	Weight per 16c. lamps.	Sq. in. of floor-space per 16c. lamps.
U. S. Steamer *Chicago.*	2 Edison No. 8 (200 lights) 2 Armington & Sims	Belting.	16,000		40	
U. S. Steamer *Boston.*	1 Brush compound (150 lights) 1 Straight Line	Belting.	10,400		70	
U. S. Steamer *Atlanta.*	1 Weston, 7 W. I. (150 lights) 1 Armington & Sims	Belting.	6,500	105 sq. ft.	43	101
Steam yacht *Alva.*	1 Siemens compound (160 lights) 1 Willans's engine	Direct. 450 Revs.	6,700	27	43	24
French ironclad *Indomptable.*	2 plants each 1 multipolar Gramme (160 lights) 1 vertical compound engine	Direct. 350 Revs.	7,040	29	44	26
Torpedo Station.	1 Brush No. 7 special (100 lights) 1 Westinghouse	Direct. 700 Revs.	4,000	17	40	25
Torpedo Station.	1 Weston No. 8 special (270 lights) 1 Westinghouse automatic	Direct. 390 Revs.	9,300	73	42	41

Lead covering is also required as a protection against mechanical injury. We are so exposed to short circuiting and corrosion from salt water that the high standard called for is most wise. All switches, junctions and safety-boxes, and in fact all parts of the circuit, should be thoroughly insulated. Difficulty has been experienced from salt water running along the wires into lamp-sockets, short-circuiting the lamps. The insulation of the whole circuit is sometimes required to be at least 1,000 ohms for each volt at the terminals of the dynamo.

In marine installations we need measuring instruments, both ammeters and volt-meters, which are independent of both gravity and magnetism. We want some kind of an instrument like a dynamometer, perhaps, which would be independent of the earth's magnetism and would not be affected by the local magnetism of the ship. Another thing which is necessary is the independence of the needle from the effect of the rolling of the ship. This has been already met by Sir William Thomson in his marine galvanometer, and, I think, in some recent instruments which I have not yet seen. The simplest way, apparently, is to suspend the magnet or needle by a suspension which passes through its center of gravity. If this is accurately done, of course the force of gravity has no moment to act upon, and the rolling of the ship does not affect the needle at all.

The Brennan Torpedo.

(From the English *Nautical Magazine.*)

THE recent experiments at Portsmouth on the old iron-clad *Resistance*, and the results of the trials of torpedo-boats in a Channel cruise, have had the effect of considerably discrediting the torpedo as a weapon in naval warfare.

It therefore comes upon us almost as a surprise, that the Government has bought the right to make a new torpedo from its inventor for so large a sum as £110,000. There is at least some satisfaction in knowing, when Imperial and colonial matters are so much in the foreground, that this very fortunate, or extremely deserving inventor is an Australian. Mr. Brennan's torpedo first came under the notice of the Admiral in command of the Australian squadron more than five years ago, and the inventor was induced to come with it to England.

A long series of experiments was instituted, most of them being carried out at Garrison Point Fort, Sheerness, a place which recommends itself as having a large extent of water, and of sands at a distance out which dry at low water; also as being a very retired spot, where secrets would be tolerably safe from the prying eyes of the correspondents of the daily press. Mr. Brennan was at once awarded £5,000 for his invention and a salary of £1,000 a year while necessary to complete and perfect it; and now he has received a further sum of £100,000.

The submarine mine is a well-known method of coast defense, but requires the protection of forts, and must be fired from a shore station, possessing the further disadvantage that it cannot be readily moved. The engineers in charge of it have to wait till the prey comes to them. The ordinary fish-torpedo, on the other hand, not only travels to meet the enemy, but the base of operations is also mobile. It may be started from a ship, from a small boat, or from a station on shore. The means of locomotion are contained in the torpedo itself; all that is necessary is to drop it into the water, and set it going in the direction of the enemy. There is a third class of torpedo, to which this new one belongs; movable, but requiring a fixed basis of operations, because the locomotive power is not contained in the torpedo itself, but is communicated to it from the shore. Some torpedos of this class are moved and steered by electricity, but the one which has now been purchased by the Government is worked by mechanical power communicated by a wire. The system of propulsion is the chief feature in which it differs from all other inventions of its class; but it will, perhaps, be more convenient to refer to this part of our subject last.

The present Brennan torpedo is 25 ft. long, 3 ft. beam and 2 ft. 6 in. depth; its weight fully equipped is 25 cwt., its speed 20 miles per hour, and range from 1½ to 2 miles.

It will run either on the surface or at any desired depth, and the depth is maintained by two horizontal rudders placed at the bow, which, by an automatic arrangement, depending upon the water pressure at any given depth, are turned up or down or kept level, as may be necessary to keep the torpedo at the required depth. This is a similar arrangement to that made use of in the Whitehead and other torpedoes. The ordinary charge is 200 lbs. of gun cotton.

One important feature is the means adopted to indicate the course to those who are steering the torpedo from the shore. At first a flag was carried along by it, but this was found to detract materially from the speed, and the method now used is to have a chamber filled with a similar composition to that used in the well-known Holmes' lights. When the torpedo is launched, water enters the chamber, and then, throughout the run, flames and smoke issuing from the composition indicate the course.

The Brennan torpedo is steered and propelled from the shore, and the real merit of the invention consists in the way in which this is done. There are two propellers, one moved by a solid shaft, and one by a hollow shaft, which encloses and runs round the solid shaft. Each shaft is connected with a large drum, the drums being in the midship compartment of the torpedo, and having, when it starts, a large quantity of wire tightly wound round each of them. The ends of the two wires pass out at the top of the torpedo, and overguides placed at its after end and running ashore are attached to a winding machine, whose rapid revolutions pull in the wires and turn the drums in the torpedo, thus turning the propellers, by means of which the vessel is driven at such a speed as to overcome the tension of the wire itself, and, further, to travel through the water at a rate of 20 miles per hour. The drums turn always in one direction, but one of the shafts has gear attached to it, which causes the propeller belonging to it to revolve always in the contrary direction. One propeller always turns from right to left, the other always from left to right. This arrangement tends to keep the torpedo in a straight course. It can, however, be steered, and this is done by means of two rudders—one on each side. By an exceedingly ingenious arrangement, which we are not able to describe in the space at our disposal, it is provided that when both propellers are turning at the same rate, both rudders are inoperative. If, however, one of the propellers is slacked, the starboard rudder comes into play, and similarly with the other. It is thus in the power of the party on shore, in charge of the winding machine, to steer the Brennan torpedo, but it can only be steered from its first course 30 to 40 degrees either to port or starboard, and it cannot be turned round. We cannot but consider the latter a most serious drawback in a torpedo actuated from a fixed base. The Brennan torpedo is driven by a pair of engines on shore, running at great speed and capable of working up to 100 H. P. The great speed of the torpedo is partly owing to its form, which is that of least resistance for submarine propulsion.

It is claimed for it that it will be less expensive than the Whitehead torpedo, as the machinery is on shore, and, consequently, the fish-torpedo itself, which is necessarily lost when used, is comparatively inexpensive. Against these advantages, however, must be put the great drawback that it can only be used from a base ashore in a fort, and by means of a heavy, fixed engine. It is certainly most difficult to understand the lavish generosity of the War Office in paying £100,000 to its fortunate inventor.

Triple-Expansion Engines.

(From the *Nautical Magazine.*)

THIRTEEN years have elapsed since a triple-expansion engine was fitted on board the steamer *Propontis*, and although it is true that, during the seven years following that event, no other cargo steamer was similarly fitted, still there has been sufficient experience to enable those immediately conversant with the working and building of this new type of engines to come to a decision as to

the practical value of this recent departure in marine engineering.

The latest contribution to technical literature on the question of triple-expansion engines is a paper read before the Northeast Coast Institution of Engineers & Shipbuilders, by Mr. J. P. Hall, Manager of the engineering department of Palmer's Shipbuilding & Iron Co., Limited, Jarrow-on-Tyne, and it is well worthy of consideration.

In the outset, Mr. Hall presents five queries:

First: Can triple-compound engines, with three cranks, be made to indicate the same power as the ordinary double compound, and only to occupy the same space in the ship? The figures adduced by Mr. Hall showed that, in many cases, a greater indicated horse-power has been obtained with triple-expansion engines, without increasing the length of the machinery space. Sometimes an engine-room is made larger than absolutely necessary, in order to obtain the advantage of the 32 per cent. deduction for propelling power from the gross tonnage; but, in all cases, if it be required, the engines can be so designed as to have three cranks, and to attain the same power as in a steamer of the same size having compound engines.

Second: Can the same indicated horse-power be obtained without increasing the total weight of machinery?

Elaborate tables have been prepared by Mr. Hall, bearing on this and other questions, and from them it appeared that from 450 to 460 lbs. per indicated horse-power was the weight of triple-expansion engines and boilers, as against 480 lbs. per indicated horse-power for compound engines. This reduced weight was attributed to the smaller boilers, condensers, pumps, valves, etc., which the higher pressure of steam permitted to be used; and, although, in the after-discussion, there was not unanimity as to the possibility of effecting a considerable saving of weight—in triple-expansion engines, constructed under ordinary commercial circumstances, Mr. Hall's figures were not materially affected.

Third: What about the wear and tear of machinery; will it be excessive as compared with the ordinary compound engine? It is satisfactory to learn that the past experience of a large number of shipowning firms confirms the opinion held by the writer of the paper, that instead of there being excessive wear and tear with triple-expansion engines, with well balanced cranks, there should be less. Messrs. Thos. Wilson, Sons & Co., of Hull, who were one of the first firms to have their steamers fitted with triple-expansion engines and have had three constantly at work since 1882, state that out of their fleet of 65 steamers, the least costly engines to maintain is a set of triple-expansions.

The adoption of metallic packing for piston-rods and feed-pumps, usual with many engineering firms, and which shipowners should insist on, tends to reduce the labor, cost and detention consequent on the use of the commoner kinds of packing, which, although found generally efficient for the lower pressure of steam employed in compound engines, are not good enough with the increased pressures of steam now in vogue.

Fourth: Will the life of the boiler be as long as that of those loaded to 80 or 90 lbs. pressure?

The answer to this question has, to many minds, been highly problematical, but, in boilers carefully looked after, it appears there is every reason to expect that the boilers used with triple-expansion engines will last longer than those of a lower pressure. This is due to various causes, amongst which figure the adoption of steel and the improved boiler-making plant and mechanical appliances now used by all first-class firms. The increased supervision of the manufacture of boilers by the Surveyors of Lloyd's Register and other interested parties has also not been without its favorable influence on the quality of workmanship and material. Mr. Hall's views on this question were amply corroborated by gentlemen who have frequently to examine steel boilers.

Fifth: Is any more skill required in looking after the machinery and boilers at sea?

As regards the engines, the answer to this question was in the negative; but, as regards the boilers, it was stated the feedwater supply should be sharply looked after. Many failures, by the collapsing of furnaces, are largely due to deposits from salt water causing the plates to become excessively hot, so that, whenever possible, fresh water should be obtained. The waste of water in boilers of high pressure should be reduced to a minimum, and scumming and blowing down should be avoided. Mr. Hall advocated the use of zinc plates and a daily supply of common soda, which gives a slight scale, in most cases, and protects the surface of the steel from pitting. The application of some easy and simple method of making on the voyage the required amount of fresh water to meet the demands of waste, etc., and thereby reduce the deposit to a minimum was also favorably noticed.

As regards coal economy in respect of vessels fitted with triple-expansion engines, the average results of vessels built by six firms of shipbuilders and manufacturers of engines showed a saving of 25 per cent., although, in comparing two steamers, practically identical in other respects, the reduced consumption of coal in the vessel with triple-expansion was 22 per cent. as compared with the ordinary compound engine.

There is a difficulty in assigning the exact amount of saving effected by the triple-expansion engine, as this advance in marine engineering has usually been accompanied by the adoption of mild steel in the hull of the vessels in place of iron. Steel vessels of 2,000 to 4,000 tons dead weight are better carriers by 7½ per cent., due to the lighter scantlings; but, allowing for this, it appears that there is a saving of 20 per cent. in the weight of coal consumed by the adoption of the triple-expansion engine and higher pressure of steam. Doubtless, this saving is further increased by the saving of port dues and other expenses, and detention incurred by more frequent re-coaling on long voyages.

Taking typical cases of steamers of 3,000 tons dead weight, steaming 250 days per annum, in the case of compound engines, 16¼ tons per diem being consumed as against 12½ tons with triple-expansion engines, at 20*s.* per ton, Mr. Hall stated the saving would represent nearly £1,000 per annum, which, on a value of £23,000 for the steamer complete, represented 4.34 per cent., without taking into consideration any other advantages the new type of engines may possess. Actual tabulated results were also given in confirmation.

The question of renewing engines and boilers in vessels fitted with compound engines was also dealt with. In the event of finances allowing it, Mr. Hall thought the better course was to take out the old engines and boilers and replace them with new ones, using the old shafting; and, where this was not advisable, he advocated the addition of a cylinder, etc., forward of the present ones; as, in placing one cylinder on top of another, the advantage of a well-balanced engine was not obtained.

It will be satisfactory for those shipowners who have steamers fitted with triple-expansion engines to learn that that type of engine will hold its own for some time to come. It is granted that quadruple-expansion engines can be worked economically at 150 to 180 lbs. pressure, but Mr. Hall considered the triple-compound—three-crank—engine will be as effective as the four cylinders arranged tandem fashion on two cranks: in the latter case, the work of the sea-going engineer being increased and rendered less accessible.

In dealing with the question of improving the efficiency of existing vessels with engines of the now nearly antiquated ordinary compound kind, it is to be regretted that prominence was not given to the advantages, from a shipowner's point of view, derivable from the adoption of forced draught which, properly considered, is germane to this aspect of the question.

The alteration of compound into triple-expansion engines has been widely advocated by engineers; but may not the increasing of work in the engineering establishments have to do with this advocacy? As regards new steamers there does not appear to be room for two opinions, but in the case of existing steamers the question assumes another aspect. There are new boilers and alterations to the engines to pay for; and, if a steamer's boilers are not worn out, it would appear to be the wiser course to adopt an approved system of forced draught,

as it has been found possible, certainly when using inferior fuel, to effect a far greater saving than by the adoption of the higher pressure steam, leaving out of consideration the far greater outlay of capital required in the latter case. If forced draught were being generally applied to boilers of 150 lbs. pressure, with a further increase in economy, possibly our views would admit of modification; but, up to the present moment, we have not learned of even isolated instances of this character.

A Method of Telephonic Communication between Ships at Sea.

[Paper read before the American Association for the Advancement of Science, at the New York meeting, by Professor Lucien J. Blake.]

In February, 1883, while investigating at Berlin the experiments of Colladon and Sturm as to the velocity of sound through the waters of Lake Geneva, the thought occurred: Why not make a practical use of water as a means of communicating between vessels at sea? Several methods were immediately devised, with the valuable suggestions of Dr. Koenig, Assistant in the Physical Laboratory of the Royal University, but actual experiment had to be deferred until a return to the United States in June of that year. At that time apparatus was prepared, and a course of experimentation has since been carried on to the present time, with more or less interruptions and more or less success. It may possibly prove interesting to learn of the methods employed and of the progress made. Further, perhaps, in the experiments, something suggestive may be found which will enable inventors to follow out in detail the system proposed. As far as the writer knows, the thought, the experiments and the whole scheme antedates all methods which have been proposed for fog signaling by telephone at sea.

Briefly, the plan was as follows: A sound-producing apparatus was to be attached to each vessel and to be worked under the surface of the water. In times of fog or night, a code of signals would be produced by it which would be transmitted in all directions through the water, with a velocity four or five times that in the air. Each vessel, in addition to the sound-producing apparatus, would be provided with a sound-receiving apparatus, which would take up out of the water the signals arriving from neighboring vessels. All of us remember when, as boys in swimming, how distinctly the sound of the striking of stones together under water was heard. Just so distinctly it is possible to send musical tones from one ship to another.

For steamships, the sound-producing apparatus was designed to be a steam fog-horn or whistle, specially constructed to sound under water, and to be heard at least from six to eight miles. From the nature of its tone it would be easily distinguishable from other sounds always more or less present under water, such as from breakers, waves, etc. With such whistles a Morse alphabet of long and short blasts and pauses was to provide a means of extended communication, while a simple universal code would indicate a ship's course. Since ignorance of the very presence of a ship, rather than incorrect estimates of her course, has been the principal cause of ocean collisions, the simple hearing of the sound would prove a most excellent general safeguard. Bell buoys were to have a second bell added under water, while lightships, light-houses and any headlands might also be provided with submerged bells which could be rung from the shore, if necessary. Sailing craft, both large and small, would have bells, and since an ordinary locomotive bell can be heard, according to my experiments, at least two miles under water, such simple means would seem to afford sufficient limits for protection for such vessels.

As to the receiving apparatus, with which each vessel was to be provided, the original plan of 1883, and which has not been changed, was to employ some form of telephone acting as a transmitter under water and connected with a receiver within the vessel. The surface of the transmitter exposed to the water, and which must receive the sound waves, must be protected against ice, barnacles, heavy waves, etc. One design was that one or more vertical pipes in different parts of a ship were to extend from the vessel's interior through the hull, near the keel, and be open to the free admission of water at their lower ends; their upper ends were to extend within the vessel a little way above the keel, and were to be plugged, so that the water could not overflow into the vessel. These pipes would then provide columns of water always still, and would communicate directly with the water outside. Sound would then enter and pass up these pipes, and would encounter microphonic transmitters placed suitably in them. Wires from the transmitters could run to a small room, secluded wherever convenient in the ship, away from disturbing noises, and here telephone receivers would be placed and observers stationed in night or fog.

For small craft it was found by my experiments that a pipe shaped much like an old-fashioned powder horn with a thin flexible membrane stretched tightly across its broad end made a successful receiver. With the small end made to fit the ear, and the diaphragm end only a few inches below water, the sound of a hand bell has been received nearly a mile distant. Colladon and Sturm used a somewhat similar receiver and heard a heavy bell 10 miles.

Such is the outline of the plan as conceived and experimented upon in 1883. In the long-distance experiments a locomotive bell or some form of gong was used, while in the laboratory, various automatic devices for producing sound under water were employed. First, it was necessary to devise the best form of receiving apparatus. Nearly all existing forms of telephones were first tried. The Bell receiver and the Blake transmitter will not work under water. The first success was obtained by a form of transmitter resembling the Ader. A cigar-box cover, from its good resonant qualities, formed the diaphragm; to this four small carbon blocks were screwed at the four corners of the square; four cylinders 2 in. long, of electric-light carbon, formed the sides of the square and rested with their taper ends lightly on the blocks; the carbons were put in series with a battery and Bell receiver. With this transmitter, with the help of E. W. Rockwood, Assistant in chemistry at Cornell, signals were transmitted and received between boats one-half mile apart on the Taunton River in 1883. The water, however, would spoil the contacts of the transmitter after a use of about 15 minutes. To obviate this the carbons were attached to the inside of a resonance box, which was then made water-tight. This, however, failed to make the transmitter markedly better. The transmitter was weighted to float at different depths, but in all positions, as regards the approaching sound waves, it received equally well. Up to about a half-mile the signals from an ordinary dinner bell were distinctly heard. The higher overtones of the bell seemed to be quenched so that the sound come muffled. The experiments seemed to indicate that a transmitter dependent upon a variable contact might yet be made which would work with satisfaction. This line was consequently followed up for the next year or so. It might be stated that, later, with apparatus similar to that already described, signals were transmitted between boats a mile distant off Stone Bridge, near Newport, R. I., in the same summer of 1883, through a rough sea and in a dense fog. These latter attendant circumstances have nothing to do, of course, with the principles of sound transmission and reception, but gave encouragement that the method was independent of the state of the water outside.

From this time, various forms of microphonic transmitters were constructed, and experiments on Long Island Sound and on the Wabash River, at Terre Haute, Indiana, were conducted as limited opportunities of time permitted.

In September, 1886, Mr. Jesse Kester, a young practical electrician, became interested, and with his valuable aid, the experiments have been carried on with many interruptions to the present summer.

One form of transmitter which has worked fairly well consists merely of a diaphragm having within itself the elements of a microphone. It is placed in simple voltaic circuit with a Bell receiver. This diaphragm it made out of hard carbon, in granules about the size of the smallest shot. A paste is made of these with rubber cement, and this, in a mold and die under heat and pressure, becomes a

hard, thin, elastic disc. The electrical resistance is very high, and can be altered according to the per cent. of rubber cement present. This disc or diaphragm takes up the sound vibrations excellently well out of the water, the rubber giving the requisite elasticity. The diaphragm vibrations produce corresponding varying pressures at the innumerable points of contact of the carbon granules. The action is of course similar to that of a multiple contact transmitter.

One difficulty, however, was found to lie in the gradual deterioration of elasticity under the action of salt water. Further, the brittleness of this diaphragm, especially when the carbon granules were comparatively large or in large proportion to the cement, rendered it liable to rupture by a strong wave or by any foreign substance striking it under water. A paste with celluloid was much tougher and seemed a slight improvement. As a transmitter in the air, this worked very nicely, and of course without the buzzing of the Blake. But no attempt was made to develop it further for this purpose.

To avoid this brittleness, diaphragms of wood and metal were tried with one or more carbon buttons. These buttons, however, differed from the Blake or Edison in that the change of pressure which produced the undulatory currents operating the receiver did not occur at the surface where the button made contact with platinum or with other carbon pieces as in these latter, but the variations of pressure took place within the button itself. To do this, these variable-pressure buttons were made as follows: Fine granules of retort carbon were sorted to uniform size through a sieve with meshes about 900 to the square inch. These were then first plated with copper, then with silver, and thirdly with a thick coat of platinum. These different platings seemed necessary to make the platinum "stick" (adhere), so to express it. At the end of the platings there remained grains of high electrical resistance, exposing many points and irregularities for contacts. These grains, in different proportions, were mixed with rubber cement and a set of hard elastic balls, about the size of peas, and thick discs molded out. These were included in a voltaic circuit with a Bell receiver, and the diaphragm rested lightly against them. Such an arrangement proved very sensitive to vibrations of the diaphragm under water. In the laboratory experiments a watch on a floating board could be heard through the water about 3 ft. distant.

On the river, however, through a long distance, these did not seem sufficiently satisfactory. This difference in action between a long and a short distance led to the thought that, as the advancing front of the sound wave is an arc, approaching in curvature nearer and nearer the tangent to its circle, a large diaphragm would receive more sonorous energy and thus probably prove more effective. This is the point to which the experiments have now been carried, and the next trials will be with a diaphragm 18 in. square.

It is believed that sufficient has been done, however, to show that the complete solution of this interesting and valuable practical scheme will lie probably in the telephonic method just described or in some modification of it; at least, by this method, in October, 1885, signals were transmitted and received 1½ miles on the Wabash River from a locomotive bell around three or four windings of the river, so that the operators were out of each other's sight, and the sound could not be heard through the air, yet could with fair distinctness through the telephone.

It is hoped that experimenters may find in the above methods and experiments enough to encourage further investigations, and with this end in view, and from the fact that the writer is, for the present, by circumstances, turned to a different line of investigation, this article has been prepared, and the experiments thus for the first time made public.

Primary Batteries.

(From the London *Times*.)

ATTEMPTS continue to be made to introduce electric lighting in the household and in mines by means of primary batteries, and we have recently inspected two more inventions of this character. The first of these is the "Eclipse" portable electric battery, which is the invention of Mr. Harris, and is being introduced by Mr. J. J. Walsh of White-house, Telegraph-street, London. This battery consists of a series of outer cells of vulcanite, each outer cell carrying an inner cell of porous material.

The outer cell is filled with a solution of sulphuric acid, and the inner cell with a solution of nitrate of soda. A carbon rod dips into each inner cell and constitutes the negative, while a plate of zinc is held in the acid solution in each outer cell and forms the positive. A miners' safety lamp has been constructed upon this principle, and a 2½-candle power lamp, assisted by a reflector, gives a very good all-round light, which is also reflected upward to the roof. At a demonstration which recently took place at Mr. Walsh's offices a number of lamps were driven from an Eclipse battery, and gave a very effective light. Upon that occasion Professor Silvanus P. Thompson spoke strongly in favor of the system, especially as applied to miners' lamps. The Great Western Railway executive, it is stated, has tested the lamp with very satisfactory results. The first cost of the battery is said to be very small, and the cost of each charge only 2*d*., which charge will maintain a lamp for 24 hours. The second primary battery to which we have to refer is the invention of Mr. C. M. Newton, and is being introduced by the New Electric Light Syndicate of 2a West-street, Finsbury, London. Each cell of this battery consists of an outer case of iron, which forms the negative plate of the cell. On the bottom of this the depolarizing material (oxide of lead) is spread. Above this is a diaphragm of parchment paper so disposed as to divide the cell into an inner and an outer compartment; and at the top, resting on glass insulators, the zinc positive plate is laid. The exciting fluid, a caustic alkali, is poured into both compartments, and the cell is ready for use. There are no fumes from this battery, which has been fully tested and favorably reported on by Dr. R. M. Walmsley, F.C.S., who states that a brilliant and steady light is maintained for 120 hours without attention, and that local action is practically negligible. It is intended to let these batteries to consumers at a nominal rental, the price to be charged to the public being fixed on the basis of gas at 4*s*. 6*d*. ($1.08) per 1,000 feet. The battery is to be recharged as required by the company, so that no risk will be incurred by domestics in dealing with it. At a recent demonstration, a good light was given by six 10-candle power Shippey Brothers' glow lamps, driven by seven Newton cells through seven E.P.S. accumulators. It is stated that the accumulators would not be used in prac tice. Including the present, we have, within the past three years, noticed no fewer than 11 primary batteries, all of which have given more or less promise during experiment. It would be interesting to know how many of these have been introduced into houses of moderate size for ordinary domestic lighting on a regular, practical and commercial paying scale to the supersession of gas

Electric Power Service.

[T. C. Martin, in the *Electrical World*.]

THE rapid introduction of electrical apparatus as soon as its efficiency has been demonstrated is being seen once more in the remarkable growth of the electric-motor industry. It was the privilege of the writer just a year ago to bring before the National Electric Light Association, in session at Detroit, a few facts and comments on the subject of the use of motors and the electrical transmission of power as it then presented itself. An enumeration was made of the various places at which motors had been introduced, and a few figures were quoted as to results obtained. But the material then offering itself, though striking, was notably scarce as compared with that forthcoming to-day; and to those who are in any way familiar with the development going on it is evident that the new work already in hand will, within the next year, dwarf into utter insignificance all that has hitherto been accomplished. Thus it may be mentioned, for instance, that

one well-known company shows a total output of over 2,000 small motors; that another concern manufacturing small motors up to about 1 H. P. has built 2,500 since last November; that another company within about the same time—nine months—has sold 1,000 H. P. of motors; that a fourth has, since going into operation, sold about 2,500 H. P., and is now building some 4,000 H. P., and that large factories have been put up for the special manufacture of motors, employing hundreds of men. The importance of this new condition of affairs is hardly yet recognized, but it cannot be denied. It means for one thing that even to-day the electric-light station is becoming the great public reservoir of power, and that from its circuits all engaged in manufacture, and thousands who need power for various minor services and functions, can draw supplies at will. In a very short time the consumption of current for electric power will equal, if not excel, the consumption for light, and it is to this new idea that electric-light men and the general public are adjusting their methods. There is not an electric-light station building to-day in which provision is not being made, in engines and dynamos, for electric-power supply; nor is there a manufacturing industry, within city limits anywhere, in which the use of electric motors is not to be tried or has not already begun.

It is, of course, well-known that several hundred small motors are in use at the present time, deriving current from primary batteries. It is also well-known that a large number of motors, averaging about 15 H. P. each, have been applied to street-railroad work; but it is through the medium of electric-lighting circuits that the greatest demand for motors has come and is to be met. In order to ascertain what is being done in this field, the *Electrical World* addressed inquiries recently on the subject to about 500 of the largest local lighting companies. It has been fortunate enough to secure replies from between 200 and 300 of these, and the replies constitute a very interesting presentation of the work done in all sections of the country. A large part of the information furnished has already been published but it may be well to bring out one or two points that are suggested by the replies as a whole.

It appears that not far short of a hundred local companies are now operating motors, generally, but not always, on their day circuits. A noticeable feature of the replies from companies not doing any motor business is that they "do not run day circuits." This may often be a sufficient reason, but the inquiry is admissible whether sufficient current could not be stored up from the average nightly run of a station with a spare or extra dynamo to feed a day circuit profitably. This is certainly worth trying in some places, and is being done at Cheyenne, where several motors are on a storage day circuit. Another point brought out is that the motors are largely on incandescent circuits, the reason for this being obviously that day running is far more a necessity with incandescent stations than with arc stations. Where motors are running upon night circuits they are chiefly employed on newspaper presses.

A question among electric-light men has been whether it is best to sell the motor or to rent it out. No unanimity has yet been attained, or is likely to be reached, on that head, although in a great many cases the matter of purchase is left optional with the customer. The sale outright relieves the company of a large initial outlay, but the leasing system seems productive of a much larger income in the long run.

Another question arising is that as to the desirability of selling power at a flat rate or by meter. Many of the companies are charging meter rates, but, on the whole, the flat rate, based on the capacity of the motor, appears to have a decided preference.

It will be remembered that the National Electric Light Association has discussed the propriety of fixing motor rates for its members. Pending that action, a striking variety has manifested itself. * * * *

It is still early for the establishment of special motor circuits, but there are several now up, and more are building in the larger cities. It is to be borne in mind that in New York and Boston a distinct electric power supply (Daft) has existed since 1883, that in New York now distributing over 200 H. P. to about 60 customers, and that in Boston 90 H. P. to about 20. Similar services exist in Worcester and Providence. A special power plant is also enjoyed by San Francisco, and the steps being taken elsewhere in the same direction are too numerous to record.

It remains to be seen whether the power supply will be generally undertaken by special power stations or whether it will chiefly remain in the hands of the lighting stations. In Boston, the Edison light station is running 72 motors (Sprague) from ½ to 15 H. P., with a total call for 300 H. P. of current, and in New York the Edison wires feed 45 motors of the same make with the same range of capacity, taking in all 250 H. P. The Brush companies in New York, Rochester, Buffalo, Galveston and Philadelphia have a large number of motors of different makes in use, and the Brush Company in Baltimore has about 60 motors (Baxter) on its arc circuits. At Providence, the Narragansett Electric Light Company is putting about 30 H. P. of motors (Thomson) on independent circuit.

One interesting development in New York City deserves special note. The Excelsior Steam Power Company, established as a private concern about 30 years ago for steam power distribution, and lately delivering nearly 800 H. P. over an area of four city blocks, went into the electric-motor business not long ago, running for the Electric Power Company the Daft service above spoken of. It is now understood that the company has completed arrangements for the generation and supply of 2,000 H. P. electrically, using the same system, and is already busy preparing its plant. This service will be confined to the district on the east side of Broadway, another service being meantime planned for the west side, to go in operation by the beginning of September. The Excelsior Company has been leasing its motors, charging $4 per week for 1 H. P., $6 for 2 H. P. and $3 for every additional H. P. This includes the current, the use of the machine, supervision and any needed repairs.

Some of the comments made are very significant, and in no case does it appear that the motor is at a disadvantage as an instrument of power distribution when compared with other machines. Thus, it is remarked by the local company at Appleton, Wis., that water-power is so cheap it would not pay them to run in the day time for electric-power supply. Yet it is in Appleton that the electric motor has made a splendid showing on street-railroad work, the generator being driven by water wheel. As to the size of motors, it may be said that it was at first thought that the bulk of the business would be around 5 H. P., but the demand is as brisk for motors of 10 and 15 H. P. and larger as for those of any other smaller capacity. All told, there are probably over 10,000 electric motors in America to-day, of some 15 different makes—Brush, Thomson, C. & C., Cleveland, Baxter, Van Depoele, Daft, Edgerton, Sprague, Hawkeye, Bergmann, Griscom, etc. Of one of these motors alone, over 30 types are now being built to fill orders and carry in stock—a point of no small importance as illustrating the remarkable commercial development of this latest electrical application.

The Pyromagnetic Dynamo—The Production of Electricity Direct from Fuel.

[Paper read before the American Association for the Advancement of Science, at the New York meeting, by Thomas A. Edison.]

THE production of electricity directly from coal is a problem which has occupied the closest attention of the ablest inventors for many years. Could the enormous energy latent in coal be made to appear as electric energy, by means of a simple transforming apparatus which accomplishes its result with reasonable economy, it will be conceded, probably, that the mechanical methods of the entire world would be revolutionized thereby and that another of those grand steps of progress would be taken, of which the Nineteenth Century so justly boasts.

The simple production of a potential difference by means of heat is as old as Seebeck and Melloni. The

science of thermo-electricity thus originated has been developed by Becquerel, by Peltier, by Thomson and by Tait, and the thermo-batteries of Clamond and of Noe have found many important practical uses. The results already attained in these generators have stimulated research marvelously, and many investigators have believed that in this direction lay the philosopher's stone. Our fellow-member, Moses G. Farmer, worked long and assiduously in this field, producing, it is believed, the most satisfactory results, as regards economy, which have ever been obtained. But even these results were not very encouraging. He never succeeded in converting 1 per cent. of the energy of the coal into electric energy. Quite recently Lord Rayleigh has discussed with his well-known ability the law of efficiency of the thermo-battery from the standpoint of the second law of thermo-dynamics; and he concludes that for a copper-iron couple, working between the extreme limits of temperature possible for these metals, a conversion of not more than one three-hundreth part of the coal energy can be hoped for. While, therefore, as a heat engine the thermo-cell appears to follow precisely the law of Carnot, and hence may have a theoretical maximum efficiency equal to that of the reversible engine of this eminent philosopher, yet in practice its efficiency falls very far below this theoretical maximum.

It therefore follows that if the result hoped for is to be attained at all it must obviously be looked for in some other direction than in that of the thermo-cell. In considering the matter, another line of investigation suggested itself to me, the results of which I have the honor now to submit to my fellow-members of the Physical Section. It has long been known that the magnetism of the magnetic metals, and especially of iron, cobalt and nickel, is markedly affected by heat. According to Becquerel, nickel loses its power of being magnetized at 400°, iron at a cherry-red heat and cobalt at a white heat. Since, whenever a magnetic field varies in strength in the vicinity of a conductor, a current is generated in that conductor, it occurred to me that by placing an iron core in a magnetic circuit, and by varying the magnetizability of that core by varying its temperature, it would be possible to generate a current in a coil of wire surrounding this core. This idea constitutes the essential feature of the new generator, which therefore I have called a pyromagnetic generator of electricity.

The principle of utilizing the variation of magnetizability by heat as the basis of electric machines, though clearly applicable to generators, was first applied to the construction of a simple form of heat engine which I have called a pyromagnetic motor. A description of this motor will help us to understand the generator subsequently constructed.

Suppose a permanent magnet having a bundle of small tubes made of thin iron placed between its poles and capable of rotation about an axis perpendicular to the plane of the magnet after the fashion of an armature. Suppose further, that by suitable means, such as a blast or a draught, hot air can be made to pass through these tubes so as to raise them to redness. Suppose that by a flat screen symmetrically placed across the face of this bundle of tubes, and covering one-half of them, access of the heated air to the tubes beneath it is prevented. Then it follows that, if this screen be so adjusted that its ends are equidistant from the two legs of the magnet, the bundle of tubes will not rotate about the axis, since the cooler and magnetic portions of the tube-bundle (*i. e.*, those beneath the screen) will be equidistant from the poles and will be equally attracted on the two sides. But if the screen be turned about the axis of rotation so that one of its ends is nearer one of the poles and the other nearer the other, then rotation of the bundle will ensue, since the portion under the screen, which is cooler, and therefore magnetizable, is continually more strongly attracted than the other and heated portion. This device acts, therefore, as a pyromagnetic motor, the heat now passing through the tubes in such a way as to produce a dissymmetry in the lines of force in the iron field, the rotation being due to the effort to make these symmetrical. The guard-plate in this case has an action analogous to that of the commutator in an ordinary armature. The first experimental motor constructed on this principle was heated by means of two small Bunsen burners, arranged with an air blast, and it developed about 700 foot-pounds per minute. A second and larger motor is now about finished, which will weigh nearly 1,500 lbs., and is expected to develop about 3 H. P. In both these machines electro-magnets are used in place of permanent magnets, the current to energize them being derived from an external source. In the latter machine the air for the combustion is first forced through the tubes to aid in cooling them, and then goes in to the furnace at a high temperature.

The earliest experiments in the direction of the pyromagnetic production of electricity were made with a very simple apparatus, consisting of a charged electro-magnet having a tube of thin iron passing through its cores near their outer ends, a coil of wire being wound around this tube, and including an ordinary sounder delicately adjusted in its circuit. The tube beneath the coil was covered with asbestos paper. After heating the tube to redness by a gas blast directed into it at one end, a jet of cold air was suddenly substituted for the flame, the sounder at once closed, showing that the change in the magnetizability of the iron had varied the distribution of the lines of force within the coil, and thus had produced a current of electricity in this closed circuit.

The construction of a machine of sufficient size to demonstrate the feasibility of producing continuous currents on the large scale in this way was at once begun and has only just been completed. The new machine consists of eight distinct elements, each the equivalent of the device already mentioned, consisting of the two legs of an electro-magnet somewhat far apart (12 in. actually), having at one end the ordinary yoke, and at the other a roll of corrugated sheet-iron, .005 in. thick, called an interstitial armature; this armature having a coil of wire wound upon it and separated from direct contact by means of asbestos paper. The eight elements are arranged radially about a common center and are equidistant, the eight interstitial armatures passing in fact through the iron disks which constitute the common pole piece of all the electro-magnets. The coils wound upon the interstitial armatures are connected directly in series, the whole forming a closed circuit. Through the center of these discs a hollow vertical shaft passes, carrying at its lower end a semi-circular plate of fire-clay called a guard-plate; which, when the shaft is turned, revolves close to the lower ends of the sheet-iron armatures and screens off half of them from the access of heat from below. The shaft carries a cylinder of insulating material having metallic contact-pieces let into it on opposite sides, the line joining them being parallel to the straight edge of the guard-plate. Upon this cylinder eight springs press, each of these springs being connected to the wire of the closed circuit above mentioned midway between the coils. The length of the metallic segment is so proportioned that the following spring touches it just as the preceding one leaves it. The springs themselves are so adjusted that each of them comes into contact with its metallic segment just as the preceding coil of the pair to which it is connected is uncovered by the rotation of the guard-plate. Upon the same shaft and above the cylinder just mentioned, a pair of metallic rings are placed, insulated from the shaft, to each of which one of the metallic segments is connected. Brushes pressing upon these rings take off the current produced by the generator.

The entire machine now described is placed upon the top of any suitable furnace, fed by a blast, so that the products of combustion are forced up through those interstitial armatures which are not covered by the guard-plate, and raise them to a high temperature. The field magnets, when charged, magnetize of course only those interstitial armatures which are cold; *i. e.*, those beneath the guard-plate. On rotating this plate, the interstitial armatures are successively uncovered on the one side and covered on the other; so that continually during the motion four of the eight armatures are losing heat, and the other four are gaining heat. But those which are losing heat are gaining magnetism and *vice versa*. Hence,

while currents are generated in all the armature coils, since in all the magnetism is varying, the current in the coils beneath the guard-plate will be in one direction, while that in the coil exposed to the fire will be in the other. Moreover, whenever an armature passes out from under the guard-plate, its condition at once changes; from losing heat and gaining magnetism it begins to gain heat and lose magnetism. Hence, at this instant the current in its coil is reversed, and, consequently, the line connecting this coil with the one opposite to it constitutes the neutral line, or line of commutation, precisely as in the ordinary dynamo. Indeed, the action of the interstitial coils of the pyromagnetic dynamo resembles strongly that of the ordinary armature coils of the Gramme ring, not only in the manner of connecting them together, but also in their functions, the change of direction in the current as the magnetism of the field changes sign in the latter case, corresponding closely to the change of current in the former case, due to the direction of the temperature change. But it will be observed that while in the Gramme ring the loops between the armature coils are connected to commutator segments equal in number to that of the coils, upon which commutator two brushes press, in the pyromagnetic dynamo the loops between the armature coils are connected to an equal number of brushes (in this case eight), while the commutator segments are only two in number; so that the functions of the commutator and brushes in this generator are in a certain sense reversed as compared with the ordinary dynamo.

The potential difference developed by this dynamo will obviously depend: 1, upon the number of turns of wire on the armature coils; 2, upon the temperature difference in working; 3, upon the rate of temperature variation, and 4, upon the proximity of the maximum point if effect.

No advantage will be gained, of course, by raising the temperature of the interstitial armature above the point at which its magnetizability is practically zero; nor will it be advantageous on the other hand to cool it below the point where its magnetism is practically a maximum. The points of temperature, therefore, between which for any magnetic metal it is most desirable to work, can be easily determined by an inspection of the curve showing the relations between heat and magnetism for this particular metal. Thus the points of temperature at which the magnetizability is practically zero, as above stated, are a white heat for cobalt, a bright red for iron and 400° for nickel. On the other hand, while at ordinary temperatures iron has a maximum intensity of magnetization represented by 1,390, its intensity at 220° is 1,360; and hence no commercial advantage is gained by cooling the iron below this temperature. Nickel, however, whose maximum intensity of magnetization is at ordinary temperatures, 800, has an intensity of only 380 at 220°. Hence, while this metal requires a lower maximum temperature it also requires a lower minimum one; but it may be worked with much less heat. The rate of the temperature variation is determined by the rapidity with which the guard-plate revolves, and this, in its turn, is dependent upon the rapidity with which the interstitial armature can be cooled and heated. That it may take up and lose heat readily, the sheet iron of which it is made is very thin (only 0.005 in. thick), even when its durability is increased by enameling or nickeling; it is corrugated and rolled up so as to expose a large surface (about 60 square feet for the eight armatures), and hot and cold air are alternately forced through the armature. Experiments already made show that the guard-plate can probably be made to revolve 120 times a minute. Since the potential difference is proportional to the number of lines of force cut per second, it is evident that by doubling the speed of rotation, twice as many lines of force would flow across the generating coils per second, and the output of energy would be quadrupled. Exactly what thickness of metal is the most suitable for the purpose, what the relative volume occupied by metal and by air space in the interstitial armature should be, what is the best diameter for this armature, or even the best metal, what the best limits of temperature, and what the best speed of rotation to produce the maximum potential difference—all these are questions which must be decided by experiments made upon the generator itself.

The results thus far obtained lead to the conclusion that the economy of production of electric energy from fuel by the pyromagnetic dynamo will be at least equal to and probably greater than that of any of the methods in present use. But the actual output of the dynamo will be less than that of an ordinary dynamo of the same weight. To furnish 30 lights of 16 candle-power in a dwelling house would probably require a pyromagnetic generator weighing two or three tons. Since, however, the new dynamo will not interfere with using the excess of energy of the coal for warming the house itself, and since there is no attendance required to keep it running, there would seem to be already a large field of usefulness for it. Moreover, by using the regenerative principle in connection with it, great improvement may be made in its capacity, and its practical utility may very probably equal the interesting scientific principles which it embodies.

An English Electric Railroad.

(From the London *Electrician*.)

On Tuesday last (July 26), upon the invitation of the Electric Traction Syndicate, the representatives of the technical journals were present at "a private demonstration of electrical traction on the Shoreham & West Brighton line." This line was built by a local company several years ago, but has never paid its way, and it has been in the hands of the Syndicate for experimental purposes for about 12 months past, during which period an elaborate series of tests have been carried out. The total length of the line is about 4½ miles, and presents features which are of considerable value for the purpose in view. The gradients are numerous and in some cases exceptionally severe, rising to 1 in 20 where the road crosses a bridge at Southwick, and there are two sharp curves of about 28 yards radius, one of which is on an incline of 1 in 100. When to this it is added that the road has not been maintained in very first rate order, it will be seen that the line is particularly well adapted to test the capabilities of any system of traction. Indeed, it may be remarked that Messrs. Aveling & Porter, the engine builders, have been experimenting with a new type of steam engine upon the same line concurrently with the electric trials. The average co-efficient of traction has been found to vary between 42 and 55 lbs. per ton, according to the state of the metals; upon a well-laid London line this co-efficient does not usually exceed 30 to 35 lbs. per ton.

The engineers of the Syndicate are of opinion that while electric traction upon lines where the cars follow one another at short intervals is best applied upon the cars themselves, yet that a wide field exists for the use of electric locomotives upon suburban lines where heavier loads are carried at longer intervals, and the conditions approximate more nearly to those of a railway. The trials upon Tuesday last began, therefore, with a short run upon an electric locomotive car weighing about 12 tons, and designed to draw a bogie car, with seats for 60 persons, at a mean speed of 8 miles an hour, additional accommodation for 14 persons being provided upon the locomotive itself. The motive power is obtained from a set of 168 A-size Tatham cells, discharging at 50 to 60 ampères, with a capacity of 200 ampère hours. The motor, which is of the Immisch type, series-wound, runs at 650 revolutions. The armature is 9 in. in diameter, and is geared direct to the driving-wheels by pinions at each end of the spindle, which mesh with internal teeth upon a circular rack on the wheel. The ratio of the teeth is 10 to 67. The motor is suspended by sleeves on journals cut in the axles, which are of steel, and has a tension bar from the center of the fields to the end framing to act as a fulcrum. But although this gearing has given good results in practice, yet it has been considered desirable to seek for a less expensive form of gear of equal efficiency; this having, it is believed, been found, it is not intended, as a rule, to resort to the arrangement just described. For this reason the trip of the loco-

motive was not of great length, nor were any measurements taken.

Returning to the engine house at Southwick a self-contained car was next tried, upon which the party made the journey to Shoreham. At this place a halt was made for lunch, and afterward the car traversed the whole length of the line to West Brighton, attaining a mean speed of slightly over 11 miles an hour; the maximum speed probably approached 16 or 18 miles an hour on some of the inclines. This car is capable of seating 20 passengers, and by itself weighs one ton; the weight of motor and gearing is one ton, and the accumulators 1.75 tons; a total rolling load, when full of passengers, of about 5.25 tons. The wheel-base measures 5 ft., and the wheels are 2 ft. 6 in. in diameter. The cells, which are 84 in number, are of the Tatham type, B-size, with a normal discharging rate of 45 to 50 ampères, and a capacity of 150 ampère-hours. They are divided into two separate batteries, each battery being again divided into two halves. By means of a suitable switch, designed by Messrs. Immisch & Co., the two halves of each battery can be connected either in parallel or in series, and the two batteries can also be connected in parallel or in series with each other. Out of these four possible arrangements it will be seen that two amount to the same thing electrically, so that only three different speeds are obtainable by this means. In actual practice it has been found that these three speeds fulfill all requirements.

The motor is again of the Immisch type, series-wound, and runs at 1,000 revolutions with 160 volts and 40 ampères. The experiments carried out by the Syndicate have largely been directed to the question of heavy motors running at slow speeds, geared direct, *versus* lighter motors running at higher speeds with second-motion gear. With slow-speed motors the question of weight assumes great importance, not only because the motor itself must necessarily be comparatively heavy, but because at slow speeds the torque is so great that the gearing and all structural parts connected with this or the motor have to be additionally strengthened. These additions to the dead weight, combined with the slower speed, necessitate also a greater current in starting and upon inclines, and thus reacts injuriously upon the batteries. A speed as low as 350 revolutions has been tried, but the experience gained has led to the conclusion that a considerably higher speed is desirable, even although the gearing becomes more complex. The motor now preferred runs at 1,000 revolutions and drives by means of chain gearing.

The chains are of a type specially designed by Mr. Hans Renolds, of Manchester, and the links are exceptionally heavy. By means of an intermediate shaft the speed of the driving-wheels is reduced in the proportion of 1 to 9, and means are provided for taking up the slack of both chains by shifting the journals. The gearing runs with great smoothness and an almost entire absence of noise; in fact, the car runs without more noise than a horse car.

The motor weighs about 5½ cwts., and has an efficiency of conversion at full load of 85 per cent. Its average working efficiency probably lies between 75 and 80 per cent. By winding the armature with smaller wire this could probably have been increased without reducing the normal output; but the element of safety which exists in an armature capable of taking an excessive current would be reduced in proportion. In this case the factor of safety as regards the sectional area of the wire is so great as to admit of the car being stopped and started upon an incline of 1 in 20. It was proposed on Tuesday to repeat this experiment, but time did not permit. The current, however, probably exceeded 100 ampères under this test.

The readings of the ammeter taken during the run showed that under an electro-motive force of 80 volts the current averaged 35 ampères on the level at a speed of 8 to 10 miles an hour, rising to 45 ampères on an incline of 1 in 120. When the cells were placed in series, giving a terminal electro-motive force of 170 volts, the mean speed increased to 12 or 14 miles on the level with a current of 45 ampères. On the incline of 1 in 20, and going round the sharp curves, the current increased to 80 ampères. These figures are little more than approximate, but were taken as a rough verification of the results obtained by more careful tests made at leisure by the engineers of the Syndicate. The limits of our space do not permit us to give a specimen of these tables in our present issue, but we shall probably return to the subject at an early date.

The Electric Traction Syndicate is certainly to be commended for the careful and thorough manner in which they have proceeded to work out the numerous problems connected with the details of the subject; and especially for their determination not to come before the public until a long series of trials of a thoroughly practical character had enabled them to undertake business with perfect confidence in their ability to carry it to a successful issue.

The Electric Lighting of Passenger Trains.

[Paper read before the American Institute of Electrical Engineers at its June meeting in New York, by G. W. Blodgett, Electrician of the Boston & Albany Railroad.]

A BETTER method of lighting passenger trains is demanded by considerations of economy, comfort and safety. Economy is a question which chiefly concerns the railroad management, but comfort and safety concern all their patrons. There are two ways in which we may seek these: either by improving the present system or by substituting a better one. It is doubtful whether oil lighting can be much improved and still be reasonable in cost, and whatever danger attends its use would probably still remain. I have made careful inquiry among my railroad friends without finding any instance, within their personal knowledge, where the ruins of a railroad wreck were set on fire by the lamps in the train (indeed these are usually instantly extinguished), but such an instance was said by one of the survivors to have occurred in the late disaster at Hartford, Vt., and another was mentioned at a recent meeting of the New England Railroad Club, where the explosion of a lamp set a sleeping-car on fire, and it burned with nearly all the occupants. It is, however, certain that a pile of splinters deluged with oil will burn more fiercely and be much more difficult to extinguish, than if in their normal condition.

It is therefore desirable to get rid of oil lamps for the harm they may do in *aiding* the progress of a fire, even if they do not cause one. The discomforts of oil lighting, in point of amount, distribution, unsteadiness and color of the light, corruption of the air, and the great heat given out by a large number of lamps in a car are other reasons why a change would be welcome to both the railroad management and the public, if a reliable substitute can be found. Some of the objections enumerated above apply with equal force to lighting by gas, the others are partially, but not wholly, eliminated. *Electricity*, however, offers a means of lighting which comes nearer to meeting all the requirements of a perfect light for passenger cars than any other yet discovered.

There are several ways in which we may produce the electricity for car lighting. It is possible to light a car successfully by any one of them, but further experiment is necessary to determine which is the very best to adopt, and we have already found some much better adapted than others to our American trains. The different methods will be considered in order.

1. By primary batteries. I only know of one experiment successfully going on at present. A train has been running for nearly a year between Paris and Brussels, the cars of which are lighted by electricity from a bichromate battery. It lasts for five trips of seven hours each—that is, 35 hours of lighting—without renewal, which is said to take only five minutes. No accurate estimate of cost, or more detailed information is yet at hand. There are several other batteries in the market which appear well, and if the motion of the train does not have a deleterious effect, would seem possibly adapted to this work. My own experience is conversant with only one trial of this kind, which did not succeed. Forty cells of a battery which had worked well in several house installations were put in boxes suspended from the bottom of a car, and 16 (?) lamps of 16 C. P. each, put up in the car. The lamps

burned well for one night, but the next night there was the appearance of a sudden and enormous increase of internal resistance in the battery, and it was removed for further experiment before trying to light cars. An attempt was made two or three months ago to light a New York Central passenger car with batteries of some kind, which also failed, as I am told.

Most primary batteries furnish a continuous current for so short a time without renewal that their use is debarred on this account. Some others will not bear the shaking up produced by the motion of the train. I have myself experimented for a considerable time, but thus far without finding a battery which will run on a closed circuit longer than two or three weeks, and at the same time can be carried on a train. When such a one can be found, which at the same time gives a current strong enough to light a series of lamps, it will have a great field of usefulness.

2. By a dynamo machine. There are three ways in which this has been done. A small dynamo and engine have been mounted on the boiler or tender, and the latter run by steam from the locomotive boiler. The great objection to this method is that there is no light until the engine is attached to the train, nor if it be temporarily removed. To obviate this difficulty, a separate boiler, engine and dynamo have sometimes been carried in the baggage car or on a platform car at the head of a train. It would seem that the danger from fire in this arrangement would be quite as great as by the stoves in the cars. A method tried with some success in a few instances in England and elsewhere abroad (but only once in this country to my knowledge), is to run the dynamo from one of the axles of the train, the proper speed being obtained by suitable countershafting and belts between the axle and the pulley of the dynamo. Since there would be no light when the train is at rest or when the dynamo was running at too low a speed, a battery of accumulators is added, sufficient to keep lamps lighted for the longest time when the train is standing in the station or elsewhere. When the train stops, or is at too low a speed for the dynamo to light all the lamps, they are automatically switched to the circuit of the accumulators, where they remain till sufficient speed is again attained, when they are switched back on the dynamo circuit, During the day, when the train is running, the dynamo charges the accumulators and keeps them full. They are sufficient to light the train several hours if need be. On one train in Germany, the dynamo and 26 accumulators weighed 1,350 pounds and cost about $625, operating 12 lamps; cost about 2 cents per hour, or 0⅙ cent per lamp per hour. The London, Brighton & South Coast Railway Company fitted up four trains in this way. In one train of 11 cars there are thirty-two 16 C. P. lamps, absorbing 40 ampères of current. The accumulators are stated to hold 500 ampères (probably 500 ampère-hours is meant), and when fully charged are stated to be sufficient to maintain the lamps for eight hours. This train has been running since December 19, 1883; during the first 11 months it made 2,352 trips, and ran 27,322 miles. No failures are reported. A train on the Southeastern Railway has even run a longer distance. The dynamos on these trains have an E. M. F. of 45 volts and give 56 ampères of current. Two pairs of brushes are mounted on a rocking frame, so contrived that, when the train runs in one direction by means of a lever loosely connected with the dynamo axle and varied in position by attraction of the pole pieces of the field magnets, it tilts the frame in the direction to bring one pair of brushes in contact with the commutator. If the train runs in the opposite direction, the other pair of brushes are brought to bear on the commutator. A vessel containing mercury has revolving within it a coarse-threaded screw driven by a belt from the dynamo-axle. At each end of the vessel is a vertical tube, at the upper end of which is an adjustable contact screw. When the dynamo, and, consequently, the screw, revolves in one direction the mercury rises in one tube. If the motion be reversed, it rises in the other tube, and when it makes contact with the screw, the shunt circuit of the dynamo is joined up, the field magnets are charged, the lever is drawn up and one pair of brushes brought to bear on the commutator, which completes the circuit for charging the accumulators. When the lamps are lighted and the train is in motion the dynamo feeds them, the accumulators merely acting as a regulator. If more current is being generated than the lamps require, it goes to the accumulators. If less, the balance is given out by them. When the speed of the train slackens the fall of mercury in one of the tubes breaks contact with the adjustable screw, the field-magnet circuit is broken, and the brushes are removed from the commutator, the lamps continuing lighted by means of the current from the accumulators.

The apparatus can be used for several weeks with no attention beyond lubrication, and at the end of this period only a re-adjustment of the commutator brushes is necessary, which puts the machine in condition for a like longer period. The weight of the apparatus is about two tons.

The connections between the cars are made by coupling two cables together. A slightly different arrangement of circuits has the field magnets of the dynamo wound with two wires in opposite directions, one of which is in shunt to the armature, as if the dynamo were an ordinary shunt machine. The other is wound as if the dynamo were a compound machine, and the accumulators are in series with this wire. The lamps are also in shunt with the armature.

There is a cut-out to break the circuit of the armature when the dynamo runs below a certain speed; this prevents the cells discharging themselves through it and burning it out. If the dynamo does not furnish current enough for the lamps, the accumulators supply the balance, and, in doing so, strengthen the field magnets and cause an increase of current in the dynamos. When this reaches a greater amount than that needed by the lamps, the surplus goes to the accumulators, and at the same time decreases the magnetism in the field magnet so as to preserve the balance. At the maximum speed of the machine, the cells are receiving their maximum charge, and the current to the lamps is of normal amount. Two sets of brushes are here necessary, as in the other case. Mr. Barrett, of Springfield, Mass., has fitted a train of three cars on the Connecticut River Railroad with electric lights to be run from a dynamo in something the same way as these just described. The peculiar arrangement of the trucks under an American car renders it a matter of difficulty to obtain the proper speed of the dynamo, and I am told Mr. Barrett has had much trouble with the connections between the axle and countershaft. If these are not kept tight the cable slips. If too tight it breaks. An ingenious device like a friction clamp transmits the power from the countershaft axle to a pulley upon it. This is governed by centrifugal weights balanced by stiff springs. When the dynamo runs at its normal speed these just balance the friction of the clamp, and there is no slip. Any increase of speed then causes the friction to diminish, and the pulley slips upon the shaft, till equilibrium is restored. Twenty-four Julien accumulators are connected with the circuit as a regulator, and to keep the lamps lighted when the train stops. A centrifugal governor breaks the circuit of the accumulators when the speed slackens.

3. A third arrangement of electric car lighting is by accumulators on the train, to be charged by a dynamo at a central station or terminus of the road. In England a Pullman train has been running some years lighted by electricity, supplied by accumulators charged when the train is at rest by a dynamo driven by a gas engine. The Pennsylvania Railroad Company experimented more than two years ago with accumulators charged at one end of the line. When the train arrived at Jersey City the trays containing the cells were removed from the car to a charging room, their places being supplied by spare cells previously charged. The empty ones were charged to be replaced in the first car needing its batteries changed, and these in turn to serve other cars. The changing of the cells in a car took about ten minutes. These experiments were in the main satisfactory, but the weak point was the life of the cells, the plates of which after a time buckled and fell to pieces. These cells were furnished by the Brush Electric Company for these experiments, but they declined to send out any more to be used in the same way until the Pennsylvania Railroad experiments should be ended. The estimated cost of fitting a car with 10 lamps and batteries for 70 ampère hours was about $300 per car.

In the month of January of the present year, the Julien Electric Company placed 60 cells of their accumulators in boxes on car No. 90 of the Boston & Albany Railroad, and put in twelve 16 candle-power lights in the car. These proved to be insufficient and the number was afterwards increased to 24, of which 20 were on the car and four over the platform. This car was run some two months as an experiment, with such excellent results that in March and April the trains leaving Boston and New York at 4.30 P. M. every day were fitted up with the same system. (These trains are also heated with steam from the locomotive, and there are no fires or oil lamps in any of the cars). Each coach and parlor car is fitted with twenty-two 16 C. P. incandescent lamps, of which two are over the platforms, 16 in the body of the car and the rest in the vestibules and toilet-rooms. The lamps in the car are arranged opposite each other in two rows in the top of the car, and are on two circuits entirely independent of each other, each of which has a switch of its own by which the lamps may be turned on or off. The platforms are so arranged as to be lighted from either end of the car. They may, if desired, be lighted only just before reaching a station and extinguished just after leaving it.

Sixty cells of Julien accumulators are arranged in boxes under the car, 30 cells on each side. The weight is about one ton. The boxes are neat and ornamental in appearance, and the 30 cells on each side of the cars are entirely independent of those on the other side, and are separately wired as far as the switch-board.

The cells have a capacity of 150 ampère-hours and 60 volts an each side of the car. As 60 volt lamps are used, the accumulators on each side of the car will run all the lamps, but of course for only half the time the whole will do it. They are arranged in trays of six cells each, furnished with handles; they weigh 200 pounds and can be raised from the ground and put in the car by two men. The trays are fitted on the outside with stiff brass springs, which, when the trays are in place, bear against each other, and form the connection between each tray and the next. When the trays are in place in the boxes the connections are all made. There are, therefore, no wires to disjoin or connections to make, when it is desired to remove a tray for examination or otherwise. From the boxes on each side of the car, wires are carried underneath the car to a switch-board in one of the toilet rooms, which also receives the terminals of the lamp circuits. The switch-board is so arranged that the number of cells in use can be varied from 27 in series to 30 in series, the others being added from time to time, to keep up the candle-power of the lamps, as the E. M. F. of the cells falls. Experiments are now being made to do away with the necessity for this, and if it is found practicable, it will be discontinued.

Two terminals underneath the middle of the car on either side serve to connect by means of plugs a pair of cables connected with wires leading to a dynamo in a lighting station a little way off. These terminals are of different size, so that no mistake can be made in the connections. When the accumulators are charged the whole 60 cells are placed in series; when they are connected to the lamps there are 30 cells in two series coupled together, In order that there should be no confusion or errors in doing this, I designed a switch which should, by a single movement in one direction, of four levers coupled together, throw all the cells in series and connect them to the dynamo circuit. In this position they are entirely detached from the lamp circuits and no current can pass to the lamps. When this switch is thrown in the opposite direction, the cells are cut off from the dynamo, coupled in two series of 30 cells each, and connected to the lamp circuits, which, however, do not light until turned on by the special switches for that purpose.

It is quite unlikely that an accident to either of the lamp circuits or the batteries on one side of the car would disable the other. By turning out the lamps on one circuit, therefore, the others may usually be kept burning till the train arrives at its destination. In two instances this arrangement of circuits has proved very valuable.

All the cars, except one, are fitted with Weston incandescent lamps, said to take 1.1 ampères. The remaining car has Edison lamps, which are proving so satisfactory that it is quite probable all new work will be equipped with the Edison apparatus.

When the train arrives at Boston it is put on a side track near which a line of poles has been set and the dynamo wires strung upon them. Opposite each car a pair of terminals serve to make connection with the car and the charging begins. A current of 18 ampères is run in for several hours, dropping to 12 and sometimes 10 ampères toward the end of the charge, which is now 180 ampère-hours to the 60 cells in series. If there were no loss we could draw out 360 ampère-hours in the lamps. Assuming that the lamps use 1.1 ampères each, we actually use about 22 × 1.1 ampère × 9 hours = about 216 ampère-hours, or 60 per cent. of what is put in. If the lamps are required an extra hour or two there is plenty of reserve for them. The attempt was made to reduce the charge to 140 or 130 ampère-hours, but as some of the batteries were not in first-class condition the results were not so good.

Mr. A. Reckenzaun, in a recent article on storage batteries, gives the average efficiency as not less then 70 per cent. The Julien Company claims, I understand, 80 to 85 per cent. for its batteries. Doubtless this can be realized under special condition, but my own experience would not warrant me in assuming so much in car lighting—at least until the most favorable conditions of use are better understood.

The intention is to always have a surplus of current in the battery. For the present, the trains run a round trip to New York and return with once charging, but it is not yet quite certain that it can be done in the long nights of winter.

The cost of fitting these cars with accumulators and lamps was, when complete, about $900 per car. Others fitted in the same way would cost less, as on this work the men were all inexperienced and there were no plans or precedents. The cost of operating the lights is not far from $2 per car per day, or about one cent per hour per lamp. When the lights are needed a longer time, as in the dark days of winter, the cost per lamp per hour would diminish. This is about ten times that of oil, and very nearly the same as for gas, but taking into consideration the amount of light obtained, electricity is the cheapest of the three, and immeasurably the most convenient. The light is very brilliant, well diffused, steady, and satisfactory beyond all expectations. A very noticeable feature of these cars is the great absence of heat, and the purity of the air, which is as fresh and sweet in the car at the end of its trip as before it leaves the first station; this, together with the absence of danger from fire, especially commends it for sleeping-cars. Several trains are now also being lighted with accumulators by the Electrical Accumulator Company with satisfactory results.

The electric light has come to stay. It is the only one which anywhere near fills the conditions of a satisfactory light for railway trains. It can be readily adapted to almost any conditions to be met with in practice.

Oil lamps and stoves in cars, must follow where the old couplers and hand-brakes for passenger trains have gone in this country, until electricity and steam heat have made the roasting alive of scores of people penned fast in a railroad wreck as impossible as the air-brake and the Miller platform have made the telescoping of a train into a shapeless mass of ruins, as was formerly the case. Not many years hence, we may well hope, one will be as uncommon as the other.

The Electric Lighthouse on the Isle of May.

[Paper read before the English Institution of Mechanical Engineers by David A. Stevenson, F. R. S. E.]

THE lighthouse situated on the Isle of May, at the mouth of the Firth of Forth, has recently been lighted with electricity; and as this light, besides being, the author believes, the most powerful in the world, possesses several novel features, he has the pleasure of offering the follow-

ing notes regarding it, trusting that they will prove of interest in connection with the visit to be made to the lighthouse on the occasion of the present meeting.

The Isle of May was originally lighted in 1636 with an open coal fire. In 1816, the Commissioners of Northern Lighthouses, having previously purchased the island with the right to levy tolls for the lighthouse, altered the light to argand lamps with silvered parabolic reflectors. In 1836, it was converted to the dioptric system, with a first order fixed light apparatus and a four-wick burner; and on December 1, 1886, the electric light was substituted and shown in connection with a dioptric condensing apparatus. For the last 15 years the Commissioners of Northern Lighthouses, acting under the advice of their engineers, Messrs. Stevenson, had been anxious to establish an electric light on the Scottish coast; but it was not till 1883 that the Board of Trade were able to sanction the expenditure, and suggested its introduction at the Isle of May on the ground that "there was no more important station on the Scottish shores, whether considered as a landfall, as a light for the guidance of the extensive or important trade of the neighboring coast, or as a light to lead into the refuge harbor of the Forth."

Notwithstanding the difficult access and isolated position of the Isle of May, distant 5 miles from the Fife shore, which is the nearest land, it was resolved to accept the view of the Board of Trade, and to introduce the electric light there. The necessary plans and specifications were accordingly prepared by Messrs. Stevenson; and the works begun in June, 1885, were completed, and the new light installed by December, 1886.

It was originally intended by Messrs. Stevenson to use the Brush compound-wound Victoria dynamo, giving a continuous current, and supplying a single automatically-fed arc lamp with the positive carbon *below*. This system was selected as being at once cheaper, and as giving a stronger light-power for the engine-power applied than the magneto-electric machines, which had hitherto, with success at least, been exclusively used in lighthouses. The placing of the positive carbon below was adopted in order that the strongest light might be thrown upward, so as to be dealt with by the upper part of the dioptric apparatus, and thus be more effectively utilized. The Brush Company at once set to work to produce a lamp of the above description, giving, with a current of 100 ampères and 70 volts, a light of 30,000 candle-power in the horizontal line, steady and suitable for burning in a lighthouse. This, unfortunately, they were unable to accomplish, even after numerous trials; and at last, as the buildings on the island were nearly completed and it became necessary at once to procure reliable apparatus, recourse was had to the more expensive alternate-current machines of De Meritens, which, though not so powerful, are admirably steady in working, and had given excellent results in several lighthouses and also at the South Foreland experiments.

The generators at the Isle of May are two of De Meritens's alternate-current magneto electric machines of the L type, and are of the largest size hitherto constructed, weighing about 4½ tons each. The induction arrangement of each machine consists of 5 sets of 12 permanent magnets, 60 in all; and each magnet is made up of 8 steel plates. The armature, 2 ft. 6 in. diameter, is composed of 5 rings, with 24 bobbins on each, arranged in groups of 4 in tension and 6 in quanity; it makes 600 revolutions per minute.

With the circuit open each machine develops an electromotive force of 80 volts measured at the distributor, and with the circuit closed through an arc, 40 volts. An average current of 220 ampères is developed, thus yielding an electrical energy of 8,800 watts, or 11.7 H. P. in the external circuit. The five rings are so arranged that one-fifth, two-fifths, three-fifths, four-fifths, or the whole of the current of a machine can at pleasure be sent to the distributor for transmission to the lantern; and, further, the two machines can be coupled, and the full current from both be employed. The machines are placed in the engine-room, bolted down to concrete foundations and driven from a counter shaft.

The engines are a pair of horizontal, surface-condensing steam engines, each with two cylinders of 9 in. diameter and 18 in. stroke, making 140 revolutions per minute, and each indicating 17.7 H. P. with 40 lbs. steam pressure above atmosphere and 11 lbs. vacuum. To provide against accident or failure of water supply, they have been arranged so as to be capable of being worked either condensing or non-condensing. Either of them is sufficient to drive one machine, the other engine being idle; or the two can be used together for driving both machines in thick weather. The steam to both cylinders is regulated by an equilibrium throttle-valve, which is controlled by a high-speed governor, adjusted for the engine to run at the normal speed of 140 revolutions per minute. Single, in place of compound, engines were adopted, because they are less complicated and better suited for the less skilled attendance of ordinary lightkeepers. Probably also, greater regularity in driving has thus been secured, which is, of course, a matter of the greatest importance in electric lighting, especially where, as is the case, there is only a single arc-lamp in the circuit forming the resistance. The result has been eminently satisfactory; and the engines, which were built by Messrs. Umpherston of Leith, are a most excellent piece of work.

There are two steam boilers, of which only one is in use at a time, the other being spare. Each is 20 ft. long, and 5 ft. 6 in. diameter, with one furnace flue 3 ft. diameter and 8 ft. long, having six cross Galloway water tubes. The shells are of best ⅜-in. steel plates, with the longitudinal joints double riveted; and they were tested up to 110 lbs. per square inch, the working pressure being 40 lbs. The feed is principally rain water collected from the roofs and the pavement of the court; but water can, if required, be taken from the small loch, which is also used for condensing purposes. The coal consumption is 1 cwt. per hour of lighting, which includes banking the fires during the day.

The current generated in the engine-room is conveyed to the lantern by leads, which consist of copper rods of 25 millimeters or 1 in. diameter, covered with a double waterproof wrapper. This is the first time that copper rods have been used for conducting the current for lighthouse illumination. They are constructed in 14 ft. lengths, the joints being formed with a zigzag scarf screwed up tightly by gun-metal coupling-boxes with four bolts in each. They are carried by timber bearers, placed in a groove made for them in the side of a concrete wall running from the engine-room to the tower. The total distance to the lantern is 880 ft. Several bends are introduced to allow for expansion and contraction due to changes of temperature. The loss in the leads was expected not to exceed one-sixth of the total energy generated; but it is considerably more than this, amounting to at least one-fifth.

The lamps, of which there are three, one in use and two spare, are of the Serrin-Berjot type, with some modifications—notably, the shunt or bye-pass, first introduced in the South Foreland experiments on the suggestion of Dr. Hopkinson, whereby a large percentage of the current goes direct to the lower carbon, and only an amount sufficient to regulate the carbons is passed through the lamp. This is a great improvement and prevents injury to the lamp from heating. The weak point about it, in the lamps sent to the Isle of May, was that the contact between the lower carbon-holder and the bye-pass, being necessarily a sliding contact, was effected by copper-wire brushes; and these were found to wear out rapidly. On the suggestion of Mr. Munro, the engineer in charge of the station, a simple form of mercury contact has been substituted, and works quite satisfactorily.

The carbons in use are 40 millimeters or 1.6 in. diameter; but if desired 50 mm. or 2-in. carbons can be used when both machines are running. They are Siemen's make and have a soft central core of pure graphite, which has the effect of causing them to burn with greater regularity and steadiness than they otherwise would, and prevents a crater from forming and remaining at one side. The rate of consumption of the 40 mm. carbons is 1¼ in. per hour, or 2 in. including waste. The power of the arc is estimated at 12,000 to 16,000 candles when one machine only is running.

The dioptric apparatus, which was manufactured from

Messrs. Stevenson's designs by Messrs. Chance, of Birmingham, is of a novel description, the condensing principle being carried further than in any apparatus previously constructed. This principle consists in darkening certain sectors by diverting the light from them, and throwing it into the adjoining sectors so as to reinforce their light. Thus, the power of the light is increased in proportion as the dark arc is increased. Although interesting we must pass rapidly over this portion of the paper, just mentioning that an arrangement is made for dipping the light during fog which has not yet been used; but as soon as the lightkeepers, who, with the exception of the engineer, were the ordinary keepers in the service and knew nothing of electric lighting, have become thoroughly familiar with their duties, it is intended to introduce it, and probably in the same way employ a less powerful current, and say 25 mm. or 1-in. carbons in very clear weather; while both machines with 50 mm. or 2-in. carbons will be used in very thick weather. The lamps can, by a carefully designed arrangement, be changed in eight seconds.

The resulting beam of light from this apparatus is about three million candles when one machine is in use, and with both machines six millions; that is, about 300 and 600 times more powerful than the old fixed oil light. When the three-wick oil lamp is put in the focus of this apparatus the emergent beam is more powerful than the old fixed oil light with a four-wick lamp, which was 9,446 candles. The light has been picked up and recognized by sailors at 40 and 50 miles off by the flashes illuminating the clouds overhead, although the geographical range of the light is only 22 miles.

The engine-room is connected by telephone with the light-room, and the houses of the keepers are connected by air whistles or electric bells with either the light-room or the engine-room.

The new buildings, engines, electric machines, lamps, etc., have cost £15,835; and the buildings, lantern, etc., previously on the island, which have been utilized, may be valued at £6,600. Thus, the total cost of the installation may be taken at £22,435; and the cost of maintenance will not exceed £1,050 per annum. These figures are very moderate, considering the great power of the light and the isolated position of the lighthouse. To compare the cost of this installation with what it would have been if oil were the illuminant, there must be added to the above £6,600 for buildings, a sum of £2,925 for the cost of the apparatus and machine, etc., making a total of £9,525, while the cost of maintenance would have been £330 per annum. Taking these figures, and adding to the maintenance 3½ per cent. on the original outlay, it is found that while the oil light would cost 3.49 shillings per hour and 0.00017 penny per candle-power per hour, the electric light costs 9.66 shillings per hour, 2¾ times more, and 0.000038 penny per candle-power, or less than one-quarter of what the oil light would cost per candle-power. This is taking the electric-light power of one machine.

Surprise has frequently been expressed by masters of vessels, and by residents on the neighboring shores who live in view of the Isle of May light, that this light, which is so extremely brilliant in clear weather as to cast shadows at a distance of 10 and 15 miles, is so cut down by fog that some even go the length of believing the old oil light was better in fog. All who have experience of the electric light are quite prepared for the first part of this statement; while the last, it need hardly be said, is a mistake, inasmuch as the electric arc has been proved both by experiment in natural and artificial fog, and also by observations on existing lighthouses lighted by electricity, to be in all circumstances of weather the most penetrating. Every night at 12 o'clock the lightkeepers at St. Abbs Head, 22 miles distant, where there is a first-order flashing light and one of the most powerful oil lights in the service, observe the Isle of May light, while the keepers there also observe the St. Abbs Head light. The result of the last five months' observations is that the Isle of May light is seen one-third oftener from St. Abbs Head than the St. Abbs Head light is seen from the Isle of May. It is perfectly true, however, that the superiority which is so apparent in clear and rainy weather is very much reduced in hazy weather and practically disappears in very dense fog. Looking to this fact and to the large first cost and annual maintenance, the author feels that the conclusion arrived at by the Trinity House is sound, namely, that electricity should be used only for important landfal lights.

If, however, the most powerful light be desired independently of cost, then the electric arc has no rival. And if the further expense is to be incurred of introducing biform, triform, quadriform or even double quadriform lights, then the electric light is better adapted than any other illuminant, because, on account of its focal compactness and other properties, it can be so dealt with by suitably designed dioptric apparatus that the whole light evolved is effectually utilized. This is not the case with the large gas or oil flames generally used in the multiform system, in which, for this and other reasons, a considerable loss of light is incurred. Moreover, the coolness of the electric arc renders multiform lights really practicable with electricity, which can hardly be said to be the case either with gas or with oil.

The author of this paper, however, inclines to the use of hyper-radiant apparatus.

Russian Petroleum.

A REPORT made to the State Department by James C. Chambers, United States Consular Agent at Batoum, gives some interesting particulars in relation to the production of petroleum in Russia, and we present below extracts from it at considerable length:

THE PETROLEUM FIELDS.

The great petroleum producing district is about 8 miles north of Baku, and is called Balakhani, taking the name of the Tartar village near it Different parts of the district are known by other names, such as Sabunchi on the south, the Garden on the east, and Shaitan Bazar in the center; and local statisticians have again subdivided the fields into groups, of which there are 17 in the Balakhani district and 1 at Surakhani, about 5 miles southeast of the main district. At Surakhani there have been 23 wells drilled, the last one I think about the year 1879, but I find no estimate for the production of these wells, and I understand that they have produced little or no oil for several years. There is also a large refinery at Surakhani, which is supplied with crude oil by pipe-line from Balakhani.

Between 2 and 3 miles south of Baku, on the seashore, is another producing district, the area of which, as at present divided, is very small, called Bibi-Eibat. Twenty-two wells have been drilled here, and 14 of them were producing in July, 1886. In September one of those wells was drilled deeper, resulting in a large flow of oil. The production of this well, it was claimed, was from 30,000 to 40,000 barrels (42 gallons each) per day for 15 days, after which it ceased to flow entirely. This well was less than 700 ft. deep, but it was the deepest well in the Bibi-Eibat district, and had been producing from a shallower depth for two years. There is also a large and very modern refinery at this place.

DEPTH OF WELLS.

The depth of the wells varies from 175 to 1,030 ft., there being only one well of the latter depth, and I am not positive that it is producing profitably. The average depth of the wells is steadily increasing, and is now said to be 500 ft. as against 350 ft. in 1882. The average depth of new wells is, however, more than 500 ft. I think it is over 600 ft. By many it is claimed that the increasing depth of the drilling is proof positive of the exhaustion of the territory, and that the depth of the drilling increases 50 ft. for every 500,000,000 gallons of crude taken out, but I have seen no calculations as to the depth of the lower strata of oil. Others claim that both the yield and the quality of the crude improves with deeper drilling, and that the territory will continue to produce from much greater depths. From my own observation, I am inclined to believe that the quality of the crude as an illu-

minant improves as the drilling gets deeper, but as to the increase in the product I am not informed.

QUALITY OF OIL.

Even here in Russia there is a great difference of opinion as to the relative merits of Russian and American illuminating oil, and while it is not generally asserted that the Russian refined can be made as good an illuminant as the American, there is no doubt that it can be and is made to burn quite good enough for all purposes, and emits no disagreeable odor while burning.

After taking from Russian crude oil say 30 per cent. illuminating distillate, about 15 per cent. is taken from the residuum, which is called "solar oil," and which, although a nice-looking white oil, is too high fire-test to burn in ordinary lamps, and not sufficiently good for lubricating purposes. This is generally mixed with the "astatki" or crude residuum, although the last Baku congress of petroleum people "*Resolved* that its use should be made compulsory for the purpose of lighting public buildings, theaters, circuses, hotels, etc., that the use of kerosene (refined) should be prohibited in such buildings, and that the ordinary restrictions applied to mineral oils, in transportation, storage, etc., should be taken off solar oil, and it placed in the same category with vegetable oils." This is, however, only a petroleum producers' resolution, which will be understood, no doubt, in America. After the solar oil is taken, the lubricating oil distillate is taken off, and varies from 20 per cent to 25 per cent. From this distillate a very good lubricant is made, as it is affected neither by intense heat nor great cold. The lubricating oil is made in Baku, but great quantities of the distillate are also shipped to England, France, Belgium and Germany, and there purified and made into lubricating oils. After the foregoing proportions are taken from the crude, the residuum, down to about 15 per cent. of the whole, is taken off, and generally mixed with the solar oil. This is called "astatki" or crude residuum, and is the fuel of southeastern Russia. As the Caspian and Volga steamers, many of the railroads in eastern Russia, and the Transcaucasian Railroad use it for fuel, there is a great demand for it, and it sells at an average price of 0.1 cent per gallon free on board cars or steamers at Baku. The 15 per cent. left in the still is called "mazoot," and, as it will not burn, is a total waste. A few years ago it was used in limited quantities to sprinkle the streets of Baku, which was a very good idea from a sanitary point of view.

Estimated as above, the yield of Russian crude in merchantable products is about 85 per cent., as follows:

	Per cent.
Illuminating oil	30
Lubricating oil	20
Solar oil / Astatki (crude residuum)	35
Waste	15
Total	100

HANDLING THE CRUDE OIL.

Iron tanks for crude oil are but seldom used, as is also iron pipe for conducting the crude from wells to reservoirs. Instead of iron pipe, wooden box-troughs or dirt ditches are used for the latter purpose, and reservoirs are made by excavating the ground in the vicinity of the well, or by simply throwing up walls with the sand that has been thrown out of the wells. Of course there is a loss from the ground absorbing the crude, but the price is so low that this loss is insignificant. From the reservoirs the crude is pumped through pipes to the refineries, which are located on the seashore, about two miles east of Baku, at Chornai-Gorod (Black Town).

The specific gravity of Balakhani crude oil varies, but not sufficiently to make any difference in its value, so that it is all run together, forming a crude of about 0.865 specific gravity, or 32° Beaume. It contains no paraffine, and very little benzine is made from it, none of which is lighter than 0.700 specific gravity. As I have said before, I think it exceedingly probable that the crude will be of a less specific gravity as the drilling deepens, as I find the oil from Nobels' No. 32 about 0.850 specific or 34½° Beaume.

The distance from the wells to refineries is about 8 miles, and as the average elevation of the wells above the Caspian Sea is 175 ft., the piping of the crude is not at all difficult. There are now 14 pipe-lines, from 3 to 6 in. in diameter, and belonging to 13 different owners. The pumps used are either of American manufacture or made in England or Russia from American patterns, with the knowledge and consent of the American manufacturers and patentees. The latter, I am informed by men of experience with both kinds, are by no means as good as those made in America, and I have heard surprise expressed at the American manufacturers allowing their machinery to be so indifferently constructed in England and Russia.

The aggregate daily capacity of the 14 pipe-lines is about 100,000 barrels. The nominal pipeage charge is 1 kopeck per pood (about 4 cents per barrel), but the pipe-lines are generally owned in connection with both wells and refineries.

MARKETING OIL.

The great market for Russian petroleum is of course Russia itself, where it is protected from American competition by a prohibitory tariff. The Russian markets are reached principally by water transportation, *via* Caspian Sea and Volga River, to the eastern termini of the Russian railroads, and thence by railroad. Barrels were formerly used for the transportation; several barrel factories were erected at Baku and one at Tsaritzin on the Volga. The machinery in these factories is principally of German manufacture, and when made was probably as good as any in America. Now, however, it is not up to the American machinery for the same purpose. Labor was, however, cheaper than steam, and the steam barrel-works were a failure. Timber for barrels was always expensive, and the increased demand which came with the increased production made some other method of transportation absolutely necessary, and the result was the construction, for Nobel Bros., in Sweden, of a steamer to carry petroleum in bulk, which proved a great success, and completely did away with the use of barrels in the Baku trade. Nobels now have 13 of these steamers in service, carrying from 4,000 to 6,000 barrels each, all of which were constructed in Sweden and brought from the Baltic Sea *via* canal to the Volga River. The short locks in the canal necessitate the steamers being constructed so as to be taken through in two pieces and again joined together when the Volga is reached. This method of getting the steamers to the Caspian is of course very tedious and expensive, notwithstanding which there is now a large fleet of them in service.

The petroleum products are carried in these bulk steamers to a point at the mouth af the Volga River called "Davit Foot" (meaning 9 ft. of water), about 400 miles north of Baku and 90 miles from Astrakhan, where they are transferred into barges which are towed by small steam tug-boats to the various distributing points on the Volga, where tanks have been constructed for their reception and arrangements made for railroad shipments. The chief distributing point upon the Volga is Tsaritzin, about 350 miles from Astrakhan, but there is also tankage at Saratof, Kazan and Nijni Novgorod. From these points it is distributed all over Russia in tank-cars. Some is also exported to Germany *via* Riga and Libau (by sea), Eidtkunen by railroad and to Austria *via* Warsaw and Brody and Pod Volochisk. Owing to the gauge of the Russian railroad system being 5 ft., while that of the continental railroad system is the standard gauge, another transfer of the oil must be made at Eidtkunen for Germany, and at Warsaw, Brody and Pod Volochisk for Austria.

The number of tank-cars in service upon Russian railroads north of the Caucasus is 2,500, or was a few months ago, as the number is constantly being increased. The tank-car is of the same style as the modern American tanks, but of uniform size and capacity, holding, nominally, 600 poods, although usually taking 660 poods or about 3,300 gallons.

Previous to the year 1883 all petroleum products were shipped from Baku by water. In that year the completion of the Transcaucasian Railroad provided another outlet to the Black Sea. Two ports on the Black Sea, Poti

and Batoum, were available for the export trade, but Batoum was selected by this trade because of the superiority of its harbor and the advantage of its being a free port. The railroad company provided tank-cars to the number of 475 in 1883, and iron tanks were erected at Batoum. A can and case manufactory, with a capacity of about 7,000 cans and 3,500 cases per day was erected by a large refiner of and dealer in Russian oil, the machinery necessary, together with the workmen to put it in running order, coming from America. Others also started to manufacture cans and cases by hand, and the business increased so rapidly that in 1884 and 1885 the railroad company added 750 more tank-cars to its rolling stock.

The railroad from Batoum to Baku is 560 miles long, aud is an exceedingly expensive road to operate, owing to the heavy grades in crossing the mountains. The highest point upon the road is the Suram Pass, about 135 miles east of Batoum, which is over 3,000 ft. above the level of the Black Sea. Upon the west side of the mountain the average grade for 3½ miles is 185 ft. to the mile, and 1½ miles of it is 238 ft. to the mile. Upon the east side of the mountain there is a grade of 253 ft. to the mile, but the greatest grade shown by the official statistics is 238 ft. to the mile for nearly 2 miles, while the average grade for 6 miles is 210 ft. to the mile. Work will soon be commenced upon a tunnel, or rather two tunnels, a long and a short one, through the mountain at Suram, which when completed will materially lessen the grade. The long tunnel will be almost 3 miles, and, as the contour of the road will have to be changed materially for 10 to 12 miles, it is estimated that the work will require about 4 years for its completion. There is some talk about the railroad capacity being temporarily increased next year by double-tracking the road over the pass, but this would also require a great deal of time and money, and I have been reliably informed that nothing of the kind is contemplated by the company. The railroad company is steadily adding new tank-cars to its rolling stock (in January 500 more tank-cars besides 350 put in service by two large refining firms). How much these additions to the tank-car service will increase the petroleum carrying capacity of the railroad I am unable to say. It requires about 1 hour and 25 minutes for a passenger-train to cross the Suram Pass, a distance of 10 miles, and for a freight-train nearly 2 hours; and with a constantly increasing general freight business it would not seem that the petroleum carrying capacity could be increased materially. The price charged by the railroad for transporting oil from Baku to Batoum is, at present rate of exchange, about 1.4 cents per gallon, and the yard charges, etc., at Batoum will increase the price to about 1½ cents per gallon.

FACILITIES FOR EXPORT.

There are now in the oil business from Batoum 10 tank-steamers, with an aggregate yearly capacity, to the ports for which they are usually chartered, of from 75,000,000 to 80,000,000 gallons; and two or three more are reported due soon, while the carrying capacity of the railroad at present is not estimated at more than 70,000,000 gallons yearly. Thus it would seem that the gratuitous (?) puffing which the Russian petroleum business has lately had in the European press, with the very plain object of sending much needed capital to its assistance, has been only doubtfully successful, inasmuch as it has resulted in sending to the assistance of the trade, not money, but ships in such numbers as to advance the price of oil their charterers are compelled to buy, in order to keep them employed, to such a figure as to make the loss from the sale of it in European markets so great as to startle even the Russian exporter, who has heretofore exhibited such a courageous disregard of financial results. The situation must undoubtedly improve; because, at present prices for Russian refined at Batoum, profitable competition with American oil at present prices at New York is impossible, even in the Levant. Some of the many steamers chartered for the trade will be compelled to remain idle at the expense of the charterer, and of course all the charterers of these vessels feel very sure that they will not suffer in this manner, but that their competitors here must, and thus allow them to continue to export at no loss, and perhaps (with an advance in prices in America) at a profit.

The lesson the Batoum trade is now learning is undoubtedly an expensive one, and may impress upon it the fact that the price of refined at Batoum, and consequently the business of exporting, are wholly dependent upon the capacity of the railroad for carrying oil from Baku to Batoum, a material increase of which seems further away than ever, since it is currently reported and believed in Tiflis that the project of tunneling the Suram Pass has been pronounced impracticable (impossible is the word used) and abandoned by the engineers who had charge of the preliminary work. Some private tank-cars will be added to the rolling stock of the railroad in the spring, but the conditions upon which these cars are accepted by the railroad company, viz., that they can only be taken over the Suram Pass after all the cars belonging to the company are out of the way, seem to indicate a doubt in the minds of the railroad officials as to their ability to handle any more cars than are now in service.

PIPE LINE.

The project of constructing a pipe line from Baku to Batoum, after having been definitely decided by a notorious English romancer, who published his specifications for the line in an English journal several months ago, was finally considered by a joint council of the ministries of Finance and State Domain, in St. Petersburg, January 12 (24 new style), and a conclusion arrived at against the construction of a line by the Government, but ostensibly favorable to the granting of a concession for the construction of a line (for crude only, and subject to strict Government control) under certain conditions, 16 in number. I have had a translation made of these conditions, and while it would no doubt prove of great interest to American readers, in showing them the remarkable ideas held by Russian pipe line experts, I do not give it because the one clause viz., "No. 10. The company must prepare all necessary pipes and reservoirs at Russian works and of Russian material," precludes any possibility of American competition for furnishing material for it, and consequently the other conditions are of no importance to Americans. I will merely say that of the 16 conditions, there are 8, any one of which would, I believe, prevent any one with even the slightest practical knowledge of the pipe-line business from accepting this concession.

Storage Batteries for Street Cars.

In a paper read before the Electrotechnischer Verein at Berlin, Herr J. L. Huber, the Engineer of the Hamburg Street Railroad, gives some very interesting details regarding the cost and operation of storage batteries on street railway lines. The system employed by Herr Huber is the Julien, in which the storage batteries are carried by the car.

In order to obtain reliable results, experiments were undertaken on a specially difficult line, both as regards curves and grades, and which, in addition, crossed much-frequented streets, so that all the difficulties met with in railroad traffic in populous cities were encountered. The road extends from the Rathhausmarkt, in Hamburg, to the Berthastrasse, Barmbeck, over the Mühlendamm, on which line very heavy grades are encountered.

The total cost given is, under these conditions, per kilometer run, for motive power, 1.5 cents; for maintenance, oil, etc., for the car motor, 0.5 cent; contingencies, 0.5 cent; renewal of plates, as above, 1 cent; a total of 3.5 cents per kilometer, or 5.6 cents per mile.

Comparing the cost of electrical power with that of horses, Herr Huber states that, to operate the usual one-horse car, which, including driver and conductor, carries 26 persons, 7 horses are required on the same line for one day of 100 kilometers run. So that, as the electric car carries 31 persons, 8.35 horses would be necessary. The cost of maintenance for horses per kilometer amounts to 4 cents (6.4 cents per car-mile). It follows, therefore, that even to-day electricity is even more economical than horseflesh, and the cost of the former can be considerably reduced by improvements.

Manufactures.

Natural Gas.

THE Louisville Gas Company, which has been boring for natural gas at a point about 25 miles below that city on the Indiana side of the Ohio River, has struck a very large flow of gas at a depth of about 400 ft. So far the flow, it is claimed, has been large enough to make the new well a very valuable one.

Aluminum and Silicon Alloys.

THE Cowles Electric Smelting & Aluminum Company, of Cleveland, O., is now manufacturing in its works at Lockport, N. Y., aluminum bronze, aluminum brass, silicon bronze and aluminum iron. The first named is an alloy of aluminum and copper; the second is made by the addition of aluminum bronze to ordinary brass. These alloys are distinguished by great strength and toughness and freedom from corrosion. Silicon bronze, an alloy of silicon and copper, has not only the qualities of strength and resistance to corrosion, but has also high electrical conductivity. Aluminum iron is a comparatively new alloy, and is used in the Mitis process for making castings of combined wrought and cast-iron.

The aluminum and silicon used in these alloys by the company is obtained by the use of Cowles's electric furnace. The company hopes to be able by this process to produce pure aluminum at a rate which will make it a commercial product in ordinary use.

Recently the oxide of chromium has been successfully reduced in the electric furnace, and an alloy containing about 12 per cent. chromium and 88 per cent. iron will be manufactured as soon as a market is assured. It is thought that this alloy will be of much service in the manufacture of chrome-steel.

Sight-Feed Lubricator Patents.

Judge Colt, of the United States Circuit Court for the District of Massachusetts, decided, on September 9, in the suit of the Seibert Cylinder Oil Cup Company against Lunkenheimer, that the Gates patent was valid.

The Gates patent is for the method of lubricating cylinders and interior working parts of steam engines showing the drops of oil passing up through water or other liquids enclosed by a transparent chamber, being that form of sight-feed lubricator known as the "upfeed."

This decision, it is claimed, covers a very large part of all sight-feed lubricators now made, and is of importance to manufacturers of those articles.

Electric Railroads.

THE electric railroad at Asbury Park, N. J., is in operation. The Daft motor is used on this line.

THE first section of the electric railroad in St. Joseph, Mo., is now in use with one car. This section is a mile long, and the overhead system is used.

THE Daft system has been adopted for the College Hill road at Easton, Pa., where a grade of 8½ per cent. has to be dealt with. The road will be about one mile long and will have three motor cars. The overhead system will be used. The cost of the road will be about $18,000 it is said.

THE electric motor of the Wharton Company, of Philadelphia, was tried recently in the presence of officers of Citizens' Passenger Railroad of Baltimore. The motor is on the storage-battery system, and the machinery and batteries weigh in all about 3,200 lbs. This motor has been tried a number of times with much success.

THE cross-town road through Fulton Street in New York City has been delayed in its construction, the conduit for the electric wires being still incomplete. It will probably be ready to work in October. The delays have been due to the electric-light junction boxes, the sewer-heads and the pipes of the water and steam-heating companies. These companies are removing their pipes at the railroad company's expense, but have been unavoidably delayed in obtaining materials. The removal of the sewer-heads has been very expensive. The engines, cars, boilers and machinery of the road are completed, and as soon as the obstructions in the streets are cleared the road will be rapidly finished.

Marine Engineering Notes.

THE Continental Iron Works in Brooklyn, N. Y., have recently taken orders for a number of their corrugated furnaces for marine boilers.

THE shipyards at Detroit, Mich., are busy, and several contracts for large vessels for next year's business on the lakes are under consideration.

THE Wheeler yard at Bay City, Mich., has just laid the keel of a wooden steamer which will be 284 ft. keel, 41 ft. beam and 23 ft. hold. She will have triple-expansion engines.

THE Milwaukee Tug Company has contracted with Reiboldt & Walters, of Sheboygan, Wis., for a 290-ft. steamer to carry 100,000 bushels of wheat. She will have triple-expansion engines and steel boilers of the Scotch pattern.

NEAFIE & LEVY, in Philadelphia, have taken a contract to build an iron steamer for the Oregon Improvement Company. The new steamer will be 240 ft. long, 35 ft. beam, 20 ft. depth of hold and will draw 12½ ft. when loaded.

THE Davidson yard at Bay City, Mich., is building two steamers for the Lake Superior trade, which are to be 235 ft. keel, 37 ft. beam and 20 ft. molded depth. The engines will be compound, with cylinders 22 in. and 46 in. diameter and 40-in. stroke.

THE new steamer *Parthian* was recently completed at the yard of the Harlan & Hollingsworth Company in Wilmington, Del. This steamer is intended for the outside line between Philadelphia and Boston, and is guaranteed to make 14 knots an hour in regular service. Her extreme length is 247 ft., beam 38 ft. and depth of hold 26 ft. The machinery consists of compound engines, with cylinders 30 and 56 in. diameter with a stroke of 54 in.

ON the night of September 7, the steamer *Pilgrim*, of the Fall River Line, broke her crosshead while off Watch Hill and was towed into New London by the steamer *Bristol*. The entire force of the *Pilgrim* at once set to work to remove the crosshead, and Mr. Pierce, Supervisor of the Old Colony Steamboat Company, immediately went to Bridgeport, Conn., and proceeded to the Bridgeport Forge Company with the broken forging. The new crosshead, weighing in all about 4 tons, was forged, fitted and ready to put on board the *Pilgrim* on the morning of September 11.

THE Detroit & Cleveland Steam Navigation Company will it is said, build a new steamer for passenger business between the two cities named. The new boat will have the same dimensions as the *City of Cleveland*, now owned by the company, as follows: Length of keel, 270 ft.; over all, 283 ft.; breadth of beam, 40 ft.; over all, 70 ft.; depth of hold, 16 ft. The hull will be of steel, and divided into water-tight compartments by steel bulkheads. She will have a low-pressure, condensing, beam engine of 2,400 H. P., with cylinders 60 in. in diameter and 12 ft. stroke and feathering paddle-wheels.

An Electric Mine Railroad.

AN electric mine railroad designed by Mr. H. M. Schlesinger is in operation in one of the Pennsylvania Railroad Company's mines, situated at Lykens Valley, in Dauphin County, Pa. The electric road proper is in drift No. 1 of the Lykens Valley collieries, and is at the present moment one mile long inside the mine and about 300 ft. outside. The drift runs into the side of the mountain.

The electric motor hauls the cars out of the end of the drift and at present brings them to daylight only, and from there they are taken by a steam locomotive to the breaker. The intention is, later on, to have the electric motor take the cars direct to the breaker. The road has an average grade of 3 in. in 100 ft., but there are two heavy grades up which the empty cars, and two heavy grades up which the loaded cars have to be hauled. The road has a large number of curves, one having a radius of 30 ft. and another a radius of 25ft. only.

The generator is placed in an engine-room outside the mouth of the drift, and from it the current is conveyed by means of a 25 lbs. rail to the motor. This rail is fastened to props at the side of the track and is from 22 in. to 5 ft. 6 in. above the track. It is put in the lower side of the gangway in such a position that the miners need not come in contact with it. Although the electro-motive force used is 350 volts, it is perfectly harmless, as has been often tested by the miners themselves. For the return current, the tie rails proper

are used, brass plates being put under the fish plates to insure a proper metallic connection between the rails. Both tie rails are joined together by a copper wire every hundred yards.

The locomotive car consists of a small wooden frame, having a wheel base 49 × 40, and 30-in. wheels. On the frame between the axles the electric motor is placed, and the power is transmitted to the axles by means of chain gearing. The electric motor proper weighs 1,500 lbs. and runs at a speed of 1,100 revolutions. The locomotive is run at a speed of 6 miles an hour, and it has already attained speeds as high as 15 miles. The number of cars it can haul is 30, each weighing, fully loaded, 4 tons. The locomotive car, with ballast, weighs about 7½ tons.

The cars have been in operation ever since July 26, doing the entire work in the drift, without a single stoppage. It is placed entirely in the hands of a boy 18 years old. The round trip is made in 25 minutes, the motor doing all the necessary shifting inside the mine. It would take mules 90 minutes to accomplish the same amount of work.—*Electrical World.*

Manufacturing Notes.

THE Western Steel Works at Carondelet (South St. Louis) are putting in a set of rolls for making steel rails of light section.

THE Builders' Iron Foundry in Providence, R. I., recently cast a bed for hydraulic press in a single block weighing 55,000 lbs.

THE Bucyrus Foundry & Manufacturing Company in Bucyrus, O., has recently shipped several steam excavators to Mexico.

THE Springfield Iron Company started up its new Bessemer-steel plant at Springfield, Ill., September 8, and is now running regularly.

H. K. PORTER & Co. in Pittsburgh, have received a number of orders lately for small locomotives or motors for street and suburban railroads.

THE Morse Bridge Works in Youngstown, O., were burned down recently, the buildings being destroyed and the tools badly damaged. They will be rebuilt at once.

THE Keystone Bridge Company in Pittsburgh has taken the contract for a new bridge over the Connecticut River at Lyme, Conn., for the New York, New Haven & Hartford road, to be completed by August of next year. The bridge will rest on the old piers, the same as the present bridge.

THE Cooke Locomotive Works at Paterson, N. J., are preparing to build ten rotary steam snow-shovels, two for the Union Pacific, four for the Northern Pacific, one for the Colorado Midland, one for the Oregon Railway & Navigation Co., one for the Central Pacific and one for sale.

E. P. ALLIS & Co. in Milwaukee, Wis., are building a quadruple-expansion stationary engine for the Warren Manufacturing Company at Warren, R. I. This engine has cylinders 24, 36, 52½ and 64½ in. diameter, all being 72-in. stroke. It is expected to work up to about 2,000 H. P. in use.

THE Burton Stock Car Company in Boston has recently contracted to carry 30,000 head of stock from the ranches to Kansas City over the Missouri Pacific road. The company has recently leased 50 new cars of its patent (built by the Carlisle Manufacturing Company at Carlisle, Pa.) to the St. Louis, Arkansas & Texas road for five years.

CONTRACTS will soon be let for a new steamboat to be run between Detroit and Cleveland for the Detroit & Cleveland Steam Navigation Company. The new boat is intended for passenger traffic chiefly, and will be 270 ft. long with steel hull. She will have a beam engine with cylinder 60 in. diameter and 12 ft. stroke and surface condensers. The paddle-wheels will be iron feathering wheels of Morgan's patent.

THE Berlin Iron Bridge Company at East Berlin, Conn., has a large number of contracts on hand, and its shops are exceedingly busy. The contracts are both for railroad and highway bridges, among the former being seven four-track bridges for the New York, New Haven & Hartford road; among the latter are spans of 240, 220, 200 and 175 ft. The company has also a large number of contracts for iron building and roofing work.

THE Grant Locomotive Works in Paterson, N. J., were partly destroyed by fire September 7, the building containing the erecting shop and principal machine shop having been destroyed by fire. The machinery in the building was all badly damaged, and part of it ruined In the loft of the building was stored a great number of old patterns, including those used in the works for many years past; all of these were destroyed. The foundry, blacksmith and boiler shops, tank and tender shops and other parts of the works escaped.

THE Boston & Albany shops at Allston, Mass., have recently turned out several new cars. They are each 57½ ft. long, weigh 51,000 pounds and seat 78 passengers. They are painted the standard color of the Boston & Albany, and, like all recently built cars of the road, are covered by the Mann roof. They are finished inside in solid mahogany, highly polished and upholstered in old gold. Each is provided with a water-closet, but the usual closet for the heater is absent, as it is proposed to heat the cars with steam from the locomotive. The cars are also wired for electric lightning, but handsome bracket oil lamps are also provided. The trucks are provided with Adams' patent dust guard.

Proceedings of Societies.

Civil Engineers' Club of Cleveland.

AT the August meeting in Cleveland, O., President Whitelaw in the chair, a long and interesting paper was read by the venerable John H. Sargent, who made the original surveys for what is now part of the Lake Shore & Michigan Southern road from Cleveland, west. Mr. Sargent gave many reminiscences of the way in which work was done at that early day, and of his experiences as a pioneer in the location and building of Western railroads.

Mr. H. C. Thompson read an interesting paper on the Method of Building Additional Tracks to a Single-track Railroad already in Operation.

Mr. C. P. Leland spoke of the manner in which a second track was laid on the Lake Shore road from Buffalo to Cleveland in a single year, under the direction of Mr. Collins, which he considered a great feat in engineering.

After a short general discussion, the Club adjourned.

Boston Electric Club.

THIS Club has been organized in Boston, with over 100 members and the following officers: President, Frank Ridlon; Vice-Presidents, W. B. Hosmer, Frank A. Houston, N. J. Hammer, Henry J. Pettingill; Secretary, Allen V. Garratt; Treasurer, Herbert H. Eustis.

The Club will meet on the first Monday evening of every month, when scientific papers will be read having special reference to electricity. Exhibits of inventions and other things which would particularly interest its members will be given from time to time at the Club Rooms, which are located at No. 66 Boylston Street. The rooms will be used for social purposes as well as for meetings.

A Proposed Engineers' Club.

A CIRCULAR has been issued, signed by some 20 prominent gentlemen, asking for opinions on the question of establishing in New York a social club for engineers, "which will bring the members of the several branches of the engineering profession into closer personal relations and afford a convenient headquarters for non-resident engineers during their visits to this city."

The signers of the circular propose to call a meeting for organization as soon as 250 eligible persons (in good standing as members of representative engineering societies) have agreed to join. The name, accommodations to be provided, etc., cannot be fully decided on till that time.

The formation of an engineering library is also part of the project.

Mr. James C. Bayles (Box 1415, New York City) is acting as Secretary of the Committee issuing the circular.

Western Railway Club.

THE first meeting for the season was held in Chicago, September 21. The first subject was Contract Work in Railroad Shops, on which a paper was read by Mr. F. D. Casanave. This paper was freely discussed by members.

The subject of Car Couplers was then taken up, and the discussion was opened by Mr. G. W. Rhodes, who gave a brief history of the Coupler Question and an account of the action of the Master Car-Builders' Association. The discussion was

continued by Messrs. Verbryck, Wadsworth, Perry, W. A. Smith, Pierce, Mackenzie, Forsyth and others.

The Club then elected officers for the ensuing year as follows: President, Godfrey W. Rhodes; Vice-President, B. K. Verbryck; Treasurer, W. B. Snow; Secretary, Angus Sinclair.

Master Car & Locomotive Painters' Association.

THE annual convention opened in New York, September 14. The Secretary reported 98 active and 20 honorary members. The following officers were elected: President, Samuel Brown, Old Colony; First Vice-President, M. W. Stines, Barney & Smith Manufacturing Company; Second Vice-President, J. J. Murphy, Louisville & Nashville; Secretary and Treasurer, Robert McKeon, New York, Pennsylvania & Ohio.

The session was mainly occupied by a discussion on the use of raw linseed oil with japan.

In the evening, the members attended a reception given them by the Painters & Decorators' Association of New York.

On the second day, papers were read and discussed on the Drying and Binding Qualities of Japan; the Quantity of Paint Required per Square Yard of Surface; the Management of the Railroad Paint Shop, and Priming Coat for Locomotive and Tank Work. The discussions were generally joined in by the members present.

On the third day, the discussions and papers were on the Best Method of Mixing and Grinding Car Body Colors; Effect of Iron Rust on Paint, and on Painting the Inside of Tender Tanks.

The Association has appointed a new Standing Committee, whose business is to answer inquiries made by members. It is called the Committee on Information and is composed of Messrs. Robert McKeon, F. M. Widser, B. B. Hodges and W. C. Fitch.

New England Railroad Club.

THE first meeting of the season was held at the Quincy House, Boston, on the evening of September 14. This meeting was devoted to the annual dinner of the club, and about 130 members and invited guests were present, with President Lauder in the chair.

After the dinner had been disposed of, President Lauder called the company to order and said he was very glad to see so auspicious an opening of the regular meetings of the Club for the fall and winter. He never saw so large an attendance before at any meeting of the Club, and he hoped that the example shown at putting in solid work would be followed by similar work at other meetings. In closing, Mr. Lauder said that Mr. J. A. Coleman, of Providence, had consented to read a paper on the Rise of the Railroads, and the Influence of Mechanical and Other Organizations on Their Progress.

Mr. Coleman spoke of his recent visit to England, the birthplace of railroads. The genius and perseverance of George Stephenson and his early inventions and triumphs were detailed at some length, and after showing that tramways, run by horses, were in use in England as early as 1750 or 1760, Mr. Coleman referred to the early history of railroads in this country, and rapidly sketched their wonderful growth up to the present year, closing by speaking briefly of the influence of such associations as the New England Railroad Club.

Miss Ada D. Noyes, of Lowell, recited a sketch entitled "Too Late for the Train," and was followed by ex-Gov. Smyth, of New Hampshire, who spoke of the important interests represented by the gentlemen before him, and the necessity of having men with brains in their ranks.

General Superintendent Jackson, of the New York & New England Railroad, spoke of the necessity of having men in the railroad service who take pride in their profession.

Mr. George H. Conant was called upon to speak for the ladies, and he was followed by Miss Noyes, who gave another recitation that received hearty applausa.

Mr. Shinn, Mr. Forney, Mr. Lewis and others, spoke briefly, and the exercise closed soon after 10 o'clock.

American Society of Civil Engineers.

A REGULAR meeting was held on the evening of September 7 at the Society's house in New York. Mr. C. C. Schneider was called to the chair.

Written discussions on Inspection and Maintenance of Bridges were presented by W. S. Lincoln and by R. A. Shaler, and read by the Secretary.

A letter was also read from Fred. C. Weir, Cincinnati, describing some Howe-truss bridges on the railroad between St. Petersburg and Moscow, Russia. These bridges were planned in 1840, and work superintended by an American. The timber used in them was planed and burnetized. In 1861, they were inspected by Mr. Harris, an old Massachusetts bridge builder, who reported that not a rotten timber was found.

Nine lithographic copies of the plans of these bridges were exhibited.

The following elections were announced: *Members*, Calvin Harlow Allen, New York; Robert Bunker Coleman Bement, St. Paul, Minn.; Peter Franklin Bredlinger, Pottsville, Pa.; Alba Fisk Brown, Pittsburgh, Pa.; George Devin, Pittsburgh, Pa.; Roscoe Edwin Farnham, Chicago; Charles Hallett, Graham, New York; Charles Harlowe, Chicago; David Christian Henny, Cleveland, O.; Edward Willard Howe, Boston; William Dunbar Jenkins, Kansas City, Mo.; Horace Greeley Johnston, Salina, Kan.; Alfred Potter Kirtland, Blairsville, Pa.; Frederick Nash Owen, New York; Alfred Holden Simpson, Newport News, Va.; Otto Frederick Sonne, Orrick, Mo.; William Starling, Greenville, Miss.; Alfred Thomas Tomlinson, Badger, Col.; Francis Stuart Williamson, Jersey City, N. J.

Juniors.—Julius Baier, St. Louis, Mo.; Gilbert James Bell, Orrick, Mo.; Frank Beresford, Cincinnati, O.; Edwin Mitchell, Norfolk, Va.; George Richard Sikes, Philadelphia; George Oliver Tenney, Decatur, Ala.; Yoshichika Wada, Orrick, Mo.

It was announced that subscriptions to the building fund now amount to $8,087. A special committee has been appointed, consisting of Messrs. T. C. Clark. D. J. Whittemore and J. M. Wilson, to solicit further subscriptions from members and others who may feel interested in the Society.

A REGULAR meeting was held at the Society's house in New York, September 21. Colonel W. H. Paine was called to the chair.

A number of photographs of the Poughkeepsie Bridge and also of the Kentucky & Indiana Bridge were on the Secretary's table.

A paper on Excessive Rainfalls by Mr. S. Whinery was read. The author instanced rainfalls at Somerset, Ky., near Meridian, Miss., and at Alexandria, La. It is to be regretted that in most cases of extraordinary rainfalls only chance data are preserved, and there is no official record. The use of good self-registering gauges by the Signal Service is recommended.

A discussion followed. Mr. Flagg mentioned a storm at St. Kitts, West Indies, in 1885, when over 30 in. of rain fell in 6 hours.

Mr. Anderson (of the Public Works Department of India) said that in Malabar a storm had occurred in which 25 in. of rain fell in 24 hours, nearly all of it in 15 hours. This rain extended over 100 square miles.

A written discussion on the Kentucky & Indiana Bridge by Mr. J. W. Schaub, was read by the Secretary. This was followed by a discussion, in which Messrs. Cooper, Emery and others took part.

Master Mechanics' Association.

THE following circulars have been issued from the office of Secretary Angus Sinclair, No. 175 Dearborn Street, Chicago:

CONCERNING CIRCULARS OF INQUIRY.

In sending out circulars of investigation, the Advisory Committee would remind the members that upon the character of the answers returned to the circulars, must, to a great extent, depend the value of the reports for next Convention. Every year, committees have had reason to make complaints of the limited number of replies returned in answer to the circular of inquiry. We urgently call upon the members to make complaint of this kind unnecessary in the future. It is very desirable that good reports should be prepared, but the data for the same ought to be supplied by individual members.

There are few members of the Association who have not facts drawn from their practice to record, which would be of value to the whole railroad world; and in numerous instances, they are kept back through mistaken modesty, or in the belief that they might not be properly appreciated. That is a mistake. Anything a mechanical man is doing, which he has not seen others doing in the same way, will excite interest. We would then earnestly press upon members not to pigeon-hole the circulars of inquiry, but to answer the questions as satisfactorily as possible, and return them promptly to the proper destination.

SPRINGS AND EQUALIZERS.

The subject of springs and equalizers is one that may be taken up from different points of view. It occurs to your Committee, however, that the principal point for them to report on would be, if possible, to establish uniformity in the size of steel for plates, and the length of spring best adapted for driver and engine trucks of the ordinary American engines. With this point in view, it is respectfully requested that each member make as full a report as possible, accompanying the same with drawings.

1. What size of steel do you consider gives the best results in locomotive-driver and engine-truck springs? It is assumed that crucible cast-steel is used, but if not, please state what kind of steel you recommend.

2. What length of spring, from center to center of hangers, gives the best results both for driver and engine-truck springs?

3. How many plates should be in each driving spring, to carry an eight-wheel passenger engine, with about 56,000 lbs. on the driving wheels, or about 14,000 lbs. on each driver?

4. How many plates for engine-truck springs with about 34,000 lbs. on truck wheels?

5. How much camber or set should such driving and truck springs have when free? How much when loaded with the above weights?

6. Do you recommend the same size of steel and distance between hangers for all classes of engines, and regulate the capacity by the number of plates, or do you have different sizes of steel to change the capacity? If the latter, please state the advantages of that plan.

7. Please state your preference for the attachment of the spring hanger—slot or stirrup—and give your reasons for the preference.

8. What is your method of applying bands? What size of iron do you use? And is there any advantage in making the bands wider at the bottom than at the top?

9. Have you had any experience in the use of bandless springs.

10. What is your practice in regard to equalizers for driving springs? Do you recommend a solid bar or one slotted for a post? Please send sketch or blue print showing equalizers and attachment, both in the center and to spring.

11. What is your practice in regard to engine truck equalizers? Please send sketch or blue print of equalizer and attachment to truck box and spring.

12. Please send sketch, or blue print, of what you would recommend as the best form of equalizer and attachment for a Mogul or two-wheel truck.

JOHN MACKENZIE,
WM. SWANSTON,
J. S. PORTER,
} Committee.

Answers to be sent to John Mackenzie, Superintendent of Motive Power, New York, Chicago & St. Louis Railway, Cleveland, Ohio.

PERSONALS.

Commander G. H. Wadleigh, U. S. N., has been ordered to duty as Navigation Officer at the Boston Navy Yard.

Assistant Engineer E. T. Warburton, U. S. N., has been ordered to special duty at the Union Iron Works, San Francisco.

Ensign Joseph L. Jayne, U. S. N., has been ordered to duty at Johns Hopkins University in Baltimore.

Lieutenant William P. Potter, U. S. N., has been ordered to duty at the Naval Academy at Annapolis.

Ensign William L. Howard, U. S. N., has been ordered to special duty in the Bureau of Navigation.

Mr. John Player has been appointed Superintendent of Motive Power of the Wisconsin Central Railroad.

Mr. F. G. Brooks is Chief Engineer of the projected Forest City & Watertown line in Dakota.

Mr. H. L. Cooper has resigned his position as Master Mechanic of the New York, Pennsylvania & Ohio, and will hereafter reside in Chicago.

Assistant Engineer Ira N. Hollis, U. S. N., has been ordered to special duty at the Manual Training School, Chicago.

Assistant Engineer H. W. Spangler, U. S. N., has been ordered to duty at the University of Pennsylvania in Philadelphia.

Assistant Naval Constructor A. W. Stahl, U. S. N., has been ordered to special duty at the shipyard of Cramp & Sons, Philadelphia.

Mr. J. C. Chase has been appointed City Engineer of Wilmington, N. C. He was recently Superintendent of the water works.

Mr. J. Van Smith is appointed Superintendent of the Philadelphia Division of the Baltimore & Ohio Railroad, in place of Mr. Wilbert Irwin, resigned.

Mr. John M. Marstellar is appointed Master Mechanic at Martinsburg, W. Va., shops, succeeding Mr. William Edwards, resigned.

Mr. Edwin F. Jones, formerly with the Louisville & Nashville, has been appointed Chief Engineer of the Buena Vista & Ellaville Railroad in Georgia.

Mr. Peter Rockwell has been appointed General Road-Master of the Union Pacific Railway, in place of Mr. Joseph McLeod, who has resigned.

Mr. A. B. Paine is Chief Engineer of the projected Poughkeepsie, Hartford & New England Railroad, and his headquarters are at Poughkeepsie, N. Y., for the present.

Professor G. Brown Goode, Assistant Director of the National Museum, has been appointed Commissioner of Fish and Fisheries, vice Professor S. F. Baird, deceased.

Mr. Frank C. Smith has been appointed Master Mechanic of the Peoria, Decatur & Evansville Railroad, with office at Mattoon, Illinois.

Mr. B. H. Bryant has been appointed Chief Engineer of the Colorado Midland Railroad, with office at Colorado Springs, Colorado.

Mr. M. V. Smith, of the Pittsburgh iron firm of Smith & Laughlan, has been appointed Consulting Engineer of the East Chicago Rolling Mill Company.

Mr. H. P. Hale has been appointed Engineer of Maintenance of Way of the Toledo Division of the Pennsylvania Company's lines.

Mr. E. St. John, late Assistant General Manager, has been appointed General Manager of the Chicago, Rock Island & Pacific Railroad.

Mr. T. F. Whittlesey is appointed Superintendent of the Kalamazoo Division of the Lake Shore & Michigan Southern road, in place of M. E. Wattles, resigned.

Mr. M. E. Wattles, late with the Lake Shore & Michigan Southern, has been appointed General Superintendent of the Chicago, Kansas & Nebraska.

The late Alfred Krupp is to be commemorated by a statue to cost $15,000, to be erected in the Market-place at Essen, Prussia.

Mr. W. Alvey has been appointed General Agent of the Baltimore & Ohio Railroad at Washington, succeeding Mr. J. F. Legge, promoted.

Mr. S. R. Callaway, formerly Vice-President and General Manager of the Union Pacific, has been chosen President of the Toledo, St. Louis & Kansas City Railroad Company.

O. H. P. Cornell, of Albany, is the Republican candidate for State Engineer of New York. He is a civil engineer by profession and a son of the late Ezra Cornell, founder of Cornell University.

Mr. J. F. Legge, General Agent of the Baltimore & Ohio Railroad at Washington, has been appointed Superintendent of the Western Division, Main Stem, succeeding Mr. C. Dunlap, resigned, dating from Sept. 15, 1887.

Mr. G. A. Thompson, late Roadmaster of the Western Division of the New York, Lake Erie & Western Railroad, has been appointed Superintendent of the Rochester Division of the same road.

Mr. H. G. Manning, formerly on the Boston & Albany road, and recently with the estate of F. W. Richardson, has accepted a position with the Hinkley Locomotive Company, of Boston.

S. W. Robinson, Professor of Mechanical Engineering, Ohio State University, has just terminated an engagement as Consulting Engineer of the Atlantic & Pacific Railroad, with a report upon the iron bridges of the road.

Mr. S. F. Woods, Chief Clerk in the office of Superintendent of Motive Power Rhodes, of the Chicago, Burlington & Quincy, has accepted a position with the Eames Vacuum Brake Company.

Mr. O. W. Stager has been appointed Assistant Superintendent of the Main Line Division, Philadelphia & Reading Railroad, with office at Reading, Pa. He has been Superintendent of Telegraph for many years.

Mr. William E. Green has been appointed Assistant Superintendent of the Chicago, Burlington & Northern Railroad, with office at La Crosse, Wisconsin. He was recently Roadmaster of the road.

Mr. A. Kimball, for 30 years connected with the Chicago, Rock Island & Pacific road, has retired from the active duties of Vice-President, but has consented to remain with the Company as Assistant to the President.

Mr. G. M. Farley is appointed Engineer of Maintenance of Way of the New York & New England Railroad, with headquarters at Hartford, Conn. He was recently with the Pennsylvania Company.

Mr. John Bogart, Secretary of the American Society of Civil Engineers, is prominently mentioned as a candidate for the office of State Engineer of New York at the coming election.

Professor M. E. Wadsworth, of Colby University, Waterville, Me., has been appointed Principal of the mining school at Houghton, Mich, in place of Professor Albert Williams, resigned.

Mr. A. K. Mansfield has removed his headquarters from Chicago to New York City, where he will continue his business as mechanical engineer, in company with Mr. George L. Mansfield, the firm name being A. K. Mansfield & Co. The removal was made October 1.

Dr. Charles W. Dabney, Jr., who has done much valuable work as State Chemist and Director of the North Carolina Agriculture Experiment Station, has accepted the Presidency of the University of Tennessee, and assumed the directorship of the Agriculture Experimental Station in the same State.

Mr. Arthur S. C. Wurtele has been appointed Deputy State Engineer of New York, in place of John Bogart, resigned. Mr. Wurtele was formerly on the New York Central, and has recently been in the Department of Public Works of New York City.

Mr. Charles E. Emery has resigned his position as Manager and Engineer of the New York Steam Company, but remains Consulting Engineer of the Company. Mr. Emery will devote himself to his practice as consulting engineer and expert.

Mr. William J. Murphy, who succeeds Mr. Benjamin Thomas as General Superintendent of the New York, Lake Erie & Western Railroad, has been for many years in the service of the road, working his way up gradually to his present position. For sometime past he has been Superintendent of the Buffalo Division.

NOTES AND NEWS.

Australian Railroads.—The Australian Intercolonial Railroad has just been completed between Adelaide, South Australia, to Melbourne, Victoria, a distance of 508 miles. From Melbourne to Sidney, New South Wales, there is already a line in operation 553 miles in length. From Sidney there is a line under construction to Brisbane, the capital of Queensland, a distance of 500 miles. The railroad system of Australia, however, is very small as yet, compared to the extent of the country.

A Great Granite Shaft.—The Bodwell Granite Company recently took out from its quarries in Maine a granite shaft 115 ft. long, 10 ft. square at the base and weighing 850 tons. It is claimed that this is the largest single quarried stone on record.

An Electric Watchdog.—A resident of Plymouth, Mass., protects his grapevines from fruit thieves in a novel manner. The supports are of wood, but the cross-pieces are of wires insulated from the ground and connected with an induction coil capable of delivering a heavy spark through an inch of air. The other pole of the coil is connected to the ground. Six good-sized bichromate of potash cells furnish electro-motive force for the coil. Short wires hanging among the wines are secured to the large wires, and when any one monkeys with the grapevine while the battery is connected the neighborhood is apt to hear from him. It works every time, and no one comes for a second dose.—*Boston Herald.*

Utilizing the Rhone at Geneva.—Arrangements are in progress to utilize the water power of the River Rhone at Geneva, Switzerland. Under an agreement lately made, the left arm of the river is to be used, the right branch being left entirely clear as an outlet for the lake. The fall obtained is from 5½ to 12 ft., and the quantity of water is estimated at about 4,700 cubic feet per second, at the lowest stage of the river. Six turbines are to be used, from which about 300 H. P. can be obtained.

An English Ship Canal.—A plan has been proposed in England for giving Birmingham the advantages of a water connection. The plan is to enlarge the present Worcester & Birmingham Canal, make some additions to the work, now existing for the navigation of the Severn River, thus carrying the navigation to Gloucester. At Gloucester, advantage will be taken of the Berkeley Ship Canal, extending to the estuary of the Severn; this will require an extension of about 6 miles to secure a better entrance. The cost of the whole project, including the purchase of the existing canals, is estimated at $10,000,000. Birmingham would be accessible for vessels of 200 tons, and would have the advantage of a water route competion.

An Earthquake Theory.—In certain disturbed regions calcareous rocks full of fissures and caverns may exist to a very great depth from the surface. The subterranean cavities which the infiltration of water has created in such places may, in spite of thr fissures which only allow water and steam to pass slowly and with difficulty, become like boilers or closed receivers containing steam under pressure and water whose boiling boiling corresponds to that pressure. These temperatures and pressures increase from one cavity to another with a force and at a measure depending on the depth below the surface.

Now, if two cavities where the pressures are diffierent come into sudden communication, either through the breaking of the partition between them or the enlargement of the fissures which connect them, there would be produced a sudden lowering of pressure in the cavity where it was the higher, and, consequently, the instantaneous transformation into steam of a part of the water contained in it; that is to say, a true explosion, of a violence sufficient to make itself felt.

If we admit an increase of te nperature of 1° for each 30 meters of distance below the surface, such phenomena as are referred to above could be produced at the relatively small depths of 4,000 to 5,000 meters below the surface.—*M. Opperman, in Revue Scientifique.*

New Wheel Lathe.—Messrs. Collier & Co., of Salford, England, have just constructed a lathe specially adapted for turning locomotive wheels after they are fixed on the axle, and it is arranged to turn the sides and tread of the wheel at one setting of the rest. The machine consists of a strong bed which is sunk level with the floor line, so that the wheel can be passed into the lathe without lifting. The headstocks are made proportionately strong to deal with wheels up to 6 ft. diameter whilst fixed on their crank axles, and the spindles are provided with steel anti-friction washers, to prevent end-thrust. The loose headstock is movable on the bed by means of rack and pinion to suit different lengths of axles, and the face plate can be run at the same or different speeds, to enable, if required, a tire to be turned at one face plate whilst a wheel is being bossed at the other. The feed motions are self-contained with the bed, and give two cuts to one revolution of the face plate. The compound rests are provided with double swivels, to enable the sides and treads of wheels to be turned without moving the saddle or rest on the bed.—*The Engineer.*

A Caucasus Railroad.—The question of constructing a railway crossing the principal chain of the Caucasus occupies the attention of the Russian Minister of Public Roads. The termini proposed are, in the north, the Darg-Koch station of the Vladikavkas Railroad, and, in the south, the Gori station of the Transcaucasian Railroad. The engineering difficulties to be encountered in the construction of the railway are immense; but they will be overcome, as others as formidable have been before them. The cost of construction, however, will be enormous. The railroad will only be about 120 miles long, of which about 11 miles will be tunnels, and the expenditure estimated, roundly, at $35,000,000, or $290,000 per mile. As the railroad will be a line of the highest military importance, expense will probably be no consideration.

Purchase of Norwegian Private Railroads.—The question of the Swedish State buying all the private railway lines in that country has, for some time, been on the *tapis*, although no definite decision has been or in all probability will be taken within the first few months. The Norwegian Government is entertaining a similar plan, and a measure to this effect is already before the Norwegian Diet. It proposes to authorize the Government to purchase through a period of three years what shares they can obtain at a certain fixed list of prices. These vary very considerably for the different companies; they are all, and most of them very much, below par. An exception in this respect is the main line, for the private shares of which it is proposed to pay 115 per cent. Should the private

shareholders not respond sufficiently to this offer, the Government will probably have to expropriate the remainder of the shares, a somewhat extreme proceeding, which they hope to avoid. The State already owns a number of shares in all the railroads, having assisted with loans or grants at the building of the railroads; the remaining shares are held by various corporations, etc., and private persons.

Railroad Rates—In the "Nationality and Railroad Policy" of the late Baron Von Weber, published in 1875, occurs the following passage: "It cannot be denied that the rates of railroads form an impenetrable chaos, in which the worst forces of secrecy, discrimination, improper motives, work without restraint, but in which, most of all, false logic has its domain. But, on the other hand, neither can it be denied that all attempts to purify, to organise, and to systematise have had for their sole result to make this chaos still more chaotic. And this is not only because, as pessimist antagonists of the railroads claim, with only partial justice, because the obscurity of the system of rates is not unwelcome to many railroad managements, but simply because it is no more possible to systematise railroad rates than the market prices of bread and meat. The utilization of railroads, whether Government or private roads, is a commercial operation, in which demand and supply, value in use and cost of production play just the same part as in every other commercial operation. Now, since the cost of performing the transportation everywhere varies like the selling price of goods, the demand and supply of transportation, the infinite permutation of these values make any logical and universally just systematisation of the rates, *a priori*, a labor of the Danaids."

Chinese Coinage.—A correspondent of the *Engineer* writes from Canton that copper or brass coins are made in China by pouring molten metal into moulds instead of stamping or impressing the device and superscription on the prepared metal discs by machinery. Very inferior work is the result, and the same correspondent says that it is not unusual for the very men who are engaged in making coins for the Government to go home and make some on their own account in the evening. They are smaller in size and made of baser metal than those made for the Government, but they pass all the same.

English Iron and Steel Production.—For the six months ending June 30, the production of pig-iron in the United Kingdom is reported by the British Iron Trade Association as follows:

	1887.	1886.
Furnaces in blast	407	396
Production, half-year, tons	3,668,115	3,536,774

The increase this year was 131,341 tons, or 3¾ per cent. On June 30 last there were 459 furnaces out of blast.

The statement for Bessemer steel production for the half-year is as follows:

	1887.	1886.
Ingots, tons	915,554	713,337
Rails	445,785	369,929
Other finished products	378,034	.....

The other finished products include plates, angles, bars, fish-plates, sleepers, castings, etc.; also blooms and billets.

Honoring an Old Engineer.—It is known that the beautiful stone bridge (1,000 ft. long) which unites the two banks of the Loire at Orleans, and which serves for the passage of the national road from Paris to Toulouse, had for its designer M. Jean Hupeau, who died in 1763, after having held for nine years the title of First Engineer of Bridges and Roads (*Premier Ingénieur des Ponts et Chausées*).

In 1884, in the course of his researches into the history of the Department of Bridges and Roads, Inspector-General Tarbé de St. Hardouin inquired if the City of Orleans had preserved the memory of M. Hupeau, and if it had given the name of that eminent engineer to any of its streets. The answer was in the negative, but the question was sufficient to call attention to the subject.

A few months since, on motion of a member of the municipal council, M. Chabassiere, a newly opened street, which reaches the right bank of the Loire obliquely, at the entrance to the bridge built in the 18th century, received the name of *Rue Jean Hupeau*, in memory of the First Engineer.—*Annales des Ponts et Chausées.*

Railroads in Siam.—Hon. Jacob T. Childs, United States Minister to Siam, writes to the State Department as follows: "At last Siam is to have a number of railroads. Last week His Majesty King Chulalongkorn granted to Capt. A. J. Loftus, his hydrographer, and Capt. A. Richelieu, two Europeans who stand high in favor with the King holding prominent positions here, concessions to build five railroads in various parts of Siam and the sole right to lay and operate for 50 years a tramway in the city of Bangkok, the latter of which will necessitate the laying of at least 20 miles of rail. The road from Bangkok to Paknam, at the mouth of the river, will be about 20 miles in length. Captain Loftus left with Prince Devawongse for England to form a company and secure proper parties and capital to build the road. The tramway in the city will be of great benefit and is a most valuable concession. The interior of Siam once opened up by railroads, a great deal of latent wealth will be developed, and they will add largely toward settling up sections that are now lying idle."

Blast Furnaces of the United States.—The *American Manufacturer* says: "Our usual monthly statement, in a condensed form, makes the following showing:

	In blast.		Out of blast.	
Fuel.	No.	Weekly Capacity.	No.	Weekly Capacity.
Charcoal	79	13,000	99	10,729
Anthracite	130	36,872	72	17,294
Bituminous	143	87,953	70	28,686
Total	352	138,725	241	56,709

"This is the largest capacity reported in blast since these reports were first begun in the *Manufacturer* in 1872.

"Compared with a month ago, there is one less charcoal furnace in blast and 496 tons capacity at furnaces using charcoal; there are three more anthracite furnaces and 1,594 tons more capacity, while at the bituminous furnaces the number in blast has increased 23, and the capacity 17,098 tons.

"The great increase this month is due, of course, to the resumption of furnaces that were laid idle by reason of the strike in the Connellsville coke region.

"A year ago—September 1, 1886—there were in blast 66 charcoal, 121 anthracite and 132 bituminous furnaces; a total of 719 furnaces, with a total weekly capacity of 121,476 tons."

Baltimore & Ohio Employes' Relief Association.—The July sheet of this Association shows the payment of benefits during the month, as follows:

	No.	Amount.
Accidental deaths	5	$5,000
Accidental injuries	366	4,344
Natural deaths	5	1,850
Sickness	553	8,248
Physicians' bills	189	1,184
Total	1,118	$20,626

The number of benefit payments from the organization of the Association has been 65,209 in all.

New Russian Steel Works.—The construction of iron-clads at Sebastopol and Nicolaeff is exercising considerable influence on the development of iron and steel works and rolling mills in the province of Ekaterinoslav. A little more than two years ago the semi-official Briansk Company increased its capital by nearly $1,250,000 in order to erect new works in the Krivoy Rog District, as a branch establishment to its colossal works at Briansk. The money was subscribed without difficulty, the works commenced, and during the the past winter 1,000 men have been employed day and night hastening their completion, in response to the pressure of the Government and the commencement of rival undertakings by foreign firms. The Krivoy Rog District is believed to contain the richest deposits of iron in the world, and the new Briansk establishment is within 20 miles of the town of Ekaterinoslav, close to the works Messrs. Cockerill are erecting. The works of the Briansk Company are expected to be finished by the end of April. They comprise large, iron-smelting sheds, steel rolling mills, and work-shops for forging and casting. At the outset, the works will be chiefly occupied in manufacturing steel plates for the South Russian iron-clads, and steel rails for the new East Russian railways. Much of the machinery now being erected has been obtained from abroad. The works lie close to the railroad, and are also connected with those at Briansk by canal and river. Their completion and the construction of the other works are expected to exercise a considerable influence not only in the development of Ekaterinoslav, but on the South Russian iron trade generally. Judging by appearances, the iron trade of Russia is rapidly shifting from the Urals and St. Petersburg to the provinces contiguous to the Black Sea, and the development of the southern fleet will hasten this movement. Reports are current that two more iron-clads are to be commenced this year at Sebastopol,

The Belgian International Exhibition.—The Belgian Government is making extensive arrangements for the great International Concourse of Science and Industry, which is fixed to take place at Brussels in 1888. The Director of the Belgian section, accompanied by several members of the general commissariat department, is now going the round of the provinces and appointing local committees in the different industrial centers. The duty of these committees will consist in grouping together the heads of local industries and inducing as many as possible to contribute to the national section. Foreign committees are being organized all over the world.

In this International Concourse the Fortieth Division will have charge of all matters relating to: 1, Civil Engineering and Public Works; 2, Architecture; 3, Materials of Construction.

Under the first head, designated as 40A, will be included all plans and designs for roads, canals and other public works; descriptions of works completed and all matters marking real progress in construction.

Under the second head—40B—will be included plans and designs for buildings of all kinds; special attention will be paid to the question of dwellings for workingmen.

The third subdivision—40C—will include tests of materials—steel, iron, stone, brick, wood etc., etc.; apparatus for tests; studies on cements, beton, etc.

The officers of Committee No. 40 are: President, M. Theodore Lamal, Brussels; Vice-Presidents, M. Wynand Janssens, Brussels, and M. Louis Berger, Schaerbeck; Secretaries, M. Desaunois, Brussels, M. Joniaux, Brussels, and M. Jean Laurent Hasse, Antwerp.

Subdivision 40A—President, M. T. Lamal; Vice-Presidents, MM. Cousin, Charles Legrand, de Raeve and Charles Van Mierlo; Secretary, M. Desaunois.

Subdivision 40B.—President, M. Wynand Janssens; Vice-Presidents, MM. Frans Baekelmans, J. Brunfaut, Ad. Pauli and Van Ysendyck; Secretaries, MM. Jean Laurent Hasse and Heyninx.

Subdivision 40C.—President, M. Louis Berger; Vice-Presidents, MM. de Matthys, Velge, Zimmer and Wolters; Secretaries, MM. Joniaux and Monnoyer.

M. Laval, on behalf of the Committee, issues a general invitation to engineers, architects and all others interested to attend and take part in the proceedings of the International Concourse.

The Mercantile Shipping of the World.—The figures given in *Lloyd's Universal Register* for 1887 are the basis of the following estimate of the total number of ships in existence at the close of 1886:

Material.	No. of Vessels.	Tonnage.
STEAMERS.		
Iron	8,198	8,911,406
Steel	770	1,206,962
Composite	109	32,820
Wood	892	380,655
Total Steamers	9,969	10,531,843
SAILING VESSELS.		
Iron	1,959	2,078,777
Steel	82	102,519
Composite	161	126,651
Wood	22,953	8,104,060
Total Sailing Vessels	25,155	10,411,807
Grand total	35,124	20,943,650

This does not include vessels of less than 100 tons, which are not included in the register.

The number of vessels owned in the leading mercantile countries of the world were:

	Steamers.		Sailing Vessels	
	No. of Steamers	Gross Tonnage.	Number.	Gross Tonnage.
Great Britain:				
United Kingdom	5,057	6,169,065	4,881	2,846,148
Colonies	735	426,806	2,559	1,097,147
Total	5,792	6,595,871	7,440	3,943,295
France	509	742,662	1,082	286,695
Germany	579	654,814	1,678	769,997
United States of America	400	503,677	3,427	1,530,490
Spain	401	356,912	725	150,113
Italy	173	230,342	1,679	712,857
Netherlands	152	175,476	514	211,762
Russia	212	153,329	944	271,849
Sweden	437	158,788	1,079	312,871
Denmark	200	140,009	648	125,189
Norway	287	142,185	3,200	1,305,337
Austria	123	145,511	350	176,821

The United States is second in number of sailing vessels, but fourth in that of steamers. Norway, which is third in the number of sailing vessels, is eleventh on the steamer list.

This list includes sea-going vessels, whether employed in coasting or trans-ocean trade, but does not include river boats and vessels employed on inland waters. It does not include war vessels.

The total number of vessels built during 1886 was 584, and their total tonnage 563 082. Of these, 315, of a total of 357,566 tons, were steamers, and 269, having a total tonnage of 205,526, were sailing vessels. Of the vessels built 197 were of iron; 179 of steel; 6 composite; and 202 of wood. The average tonnage of the iron and steel vessels was nearly three times that of the wooden ships.

The Naval War College.—The session of the Naval War College was formally opened on Coaster's Harbor Island on September 5. The official programme for the present course requires that the session shall end December 22. There will be two lectures each day, except Saturday and Sunday, as follows:

September: Naval Gunnery, treated with Special Reference to the Influence of the Gun upon Naval Tactics, by Lieutenant J. F. Meigs, 18 lectures.

Naval Tactics and Current Theories Respecting Them, by Commander W. B. Hoff 8 lectures.

Duties of General Staff, by Lieutenant C. C. Rogers, 4 lectures.

International Law, by Prof. J. R. Soley, 8 lectures.

October: International Law, by Professor J. R. Soley, 12 lectures.

Tactics of the Gun, by Lieutenant J. F. Meigs, 4 lectures.

Tactics of the Torpedo, by Lieutenant D. Kennedy, 3 lectures.

Naval History, by Captain A. T. Mahan, 10 lectures.

Coast and Defense, by Lieutenant C. G. Calkins, 4 lectures.

November: Coast Defenses, by Lieutenant C. G. Calkins, 8 lectures.

Defenses of the Seacoast of the United States, by General H. L. Abbot, U. S. Engineers, 5 lectures.

Naval History, by Captain A. T. Mahan, 8 lectures.

Military History, Strategy and Tactics, by Lieutenant T. H. Bliss, U. S. Army, 12 lectures.

Preservation and Care of Iron Ships and Injuries, by Assistant Naval Constructor R. Gatewood, 4 lectures.

Naval War Game, by Lieutenant McCarty Little, 6 lectures.

December: Naval Hygiene, by Medical Director R. C. Dean, 6 lectures.

Military History, etc., by Lieutenant T. H. Bliss, U. S. Army, 12 lectures.

Present Condition of Commerce and Commercial Routes between Europe and the Pacific, with an estimate of the effect produced upon them by a trans-isthmian canal, including a view of the Military and Political Conditions of the Pacific, Gulf of Mexico and Caribbean Sea, by Lieutenant-Commander C. H. Stockton, 6 lectures.

Natural Gas and Oil in the West.—The sinking of a large number of test holes for natural gas and oil in various parts of Illinois, Missouri, Kansas, Iowa, Texas, Colorado, Arkansas and Nebraska will determine in the near future the extent and value of these deposits. Thus far, the results in most of the States named have not been encouraging. Outside of the 20 or more counties south of the Wabash River in Indiana, and west of Indiana, nothing worth mentioning has been discovered. And if the opinions of experts are worthy of consideration, the productive territory in Indiana and Ohio has been quite thoroughly determined. Outside the territory mentioned the Trenton limestone either comes too near the surface, or the other conditions which appear to be necessary for the finding of large quantities of gas do not exist. A considerable amount of drilling in Kentucky has failed of its object, with the possible exception of the recently reported strike 25 miles down the Ohio River from Louisville.

From various parts of Illinois, particularly the central portion, come almost daily reports of the discovery of natural gas in shallow wells ranging from 50 to 200 ft. in depth. Whether this gas comes from decaying drift or through fissures from a carboniferous formation below the drift is a question not yet determined. These shallow deposits appear to be particularly plentiful in Champaign, Coles, De Witt and Tazewell Counties. It is certain, however, that the deep wells at Jacksonville, Beardstown, Springfield and Shelbyville have not revealed the presence of gas in commercially valuable quantities. Deep holes are being put down at Decatur, Charleston, Mattoon, near Pekin, and at a number of other places, and the results of these tests will be watched with a great deal of interest. The deep well sunk by the manufacturers of St. Louis near Edwardsville, Madison County, is down 1,685 ft., and up to this writing is unproductive. It

may be said, therefore, that, aside from the wells at Litchfield, the drill has failed to find large bodies of gas or oil in Illinois.

The results in Missouri have not been any more encouraging than in Illinois. In the southwestern part of the State five or six deep wells have turned out dry holes. At a dozen or more places—notably St. Charles, Mexico, Palmyra and Sedalia—test holes are now being put down. At Fort Smith, Ark., a local company has been organized to drill a 2,000-ft. well, and in Texas a score or more of wells are approaching completion. From Iowa come reports of surface gas, but we are unable to learn of anything very large or valuable. In Eastern Kansas there are several places where natural gas is utilized for heating and manufacturing purposes. The Colorado oil fields have been worked in a mild way for nearly 15 years, and the recent discoveries near Fremont are certainly very promising. It is currently reported that the Standard Company has acquired an immense tract of land about Fremont and will at once give the field a thorough test.—*Age of Steel.*

Steamboats in Colombia.—Consul Edmund W. P. Smith, writing to the State Department from Carthagena, Colombia, says: "When I came here the Colombians were buying river steamers in the United States. They never thought of going to England for light-draft, stern-wheel steamers—to a country where there are no navigable streams suited for boats of that class. I must protest that it is not the fault of the Consul that the Columbians now prefer and are giving their orders for English-built boats in preference to those made in the United States.

"Repeated attention was called in reports from this Consulate that the American boats were not giving the satisfaction they should. The English-built boats consume less fuel, cost less and are lighter built. Take the Dique Steamboat Company, that runs light-draft steamers between this port and Honda, the head of navigation on the lower Magdalena River. The first steamer of this company was built in the United States. It could run very fast but consumed an enormous quantity of fuel and carried but a small cargo. The second boat was built in England; it runs as fast as the one built in the United States, consumes half the quantity of fuel and cost just one-half the money paid for the American boat. The result has been that American-built boats are at a discount here, and the English boat-builders are receiving numerous orders.

"Within the past three years the Dique Steamboat Company has purchased three steamers from Yarrow & Co., of London. It is safe to estimate that over $250,000 have been lost to American steamboat-builders within two years by their apparent indifference to the wants of the steamboat trade of Colombia rivers. The Americans know that they can and do build river steamers better than the English, but unfortunately the Colombians don't know it.

"Unquestionably, river steamboat building in the United States is languishing on account of railroad competition: Then why not turn their attention—the steamboat builders—to South American rivers, where there is no opposition by land? On the great Magdalena River nearly 30 river steamers are now plying. Two other rivers in Colombia, almost equal in commercial importance to the Magdalena, namely, the Atrato and Sinu, will soon have lines of steamers operating upon them. A company, heavily subsidized by the Colombian Government, and partly American, will shortly place three steamers on the Atrato and Sinu rivers. This Company, although desiring to have its boats built in the United States, I am afraid will give the contract to an English boat-builder."

Surveys of India.—The Topographical Survey of India has formed a branch of the Government machinery almost ever since the British occupation of the country. Its chief work has been in local surveys and marking boundaries, as was required by the peculiar tenures of land and methods of taxation in use in the country. Other work has been done, however, in special fields, which has been of value in the advancement of geography and of science in general. The special work of this class done last year is summed up by *Indian Engineering* as follows:

"*Himalaya Party*—Continued the operations of the previous years in the topographical survey of the Hill States about Simla, and of the demarcation of the Nepal boundary in Mechi River, 24 miles of which was demarcated, but the erection of pillars was left over to be taken up on completion of the entire line of boundary. The party also undertook to bring up the arrears of mapping connected with the Nepal boundary survey, the Sikkim triangulation and the Darjeeling revisionary and Dahing lands surveys.

"*Afghanistan.*—A good deal of substantial work was carried on during the year under review under the head of Geographical Survey and reconnoissances. It was highly creditable to the officers of the Afghan Boundary Commission that the very large area of 120,000 square miles was surveyed in that country. The entire province of Herat, including the hitherto unknown Taimani and Firozkuhi country was mapped; almost the entire province of Afghan Turkistan, with a large portion of the Haraza country in the vicinity of Bannian was reconnoitered or surveyed; and on the return march of the Commission, all important passes of the Hindoo Koosh were surveyed.

"*Upper Burmah.*—In this country, Captain Hobday, with a small party of surveyors, made a reconnoissance survey round Mandalay and compiled the reconnoissance sketches executed by officers with the Burmah field force. Captain Hobday and a surveyor joined two military expeditions, one to the Kuchin Hills and the second to the southeast of Mandalay. They succeeded in extending triangulation southward as far as latitude 21 and in surveying an area of 150 miles on the ½-in. scale."

Maps to the number of 210,288 were printed and issued, and a number of large special maps were made for the Colonial Exhibition in London.

Rapid Transit in New York.—The latest Rapid Transit Commission appointed in New York City has completed its labors and submitted a report to Mayor Hewitt, urging the inability of the present elevated roads to carry the traffic, and recommending the building of a via uct line through the blocks. In opening their report the Commissioners say:

"The petition to Your Honor upon which our appointment was made asks for a steam railroad from a point on the easterly line of Broadway, near the City Hall Park, to a point of junction with the authorized line of the New York Underground Railroad Company south of Fourteenth Street.

"We are prohibited by the express terms of the law from extending such road in either direction necessary to give rapid transit. In this we are confirmed by the opinion of the Counsel to the Corporation. We accordingly decline to accede to the request."

After quoting the law on the subject they continue:

"The growth of the city is so rapid that even now the elevated roads can no longer carry comfortably the number of passengers. The remedy seems to us to be a railroad from Forty-second Street to Wall Street or South Ferry, to be extended northward as travel demands.

"Such a road, to be of service, should be as central and direct as possible, and the trains run at a speed of at least 25 miles per hour.

"We are led to the conclusion that there is but one way to obtain such rapid transit, and that is by the construction of a solid viaduct line through the blocks, as far as possible, and when compelled to cross or follow the lines of streets to be constructed with much greater strength and solidity than the present elevated railroads. Such a viaduct road should be built in accordance with the following conditions:

"The structure should be built through the blocks of brick and stone in the most solid manner. The streets should be crossed by massive steel girders with solid steel floors, having no openings. The track should consist of heavy steel rails on ties laid in an elastic material between floor and ties. There would be no jar or break of continuity of motion in such a structure, and trains could be run at high speed with little noise.

"The stations should be not less than one-half mile apart and long enough for 10 cars. The cars should be as wide as possible.

"Trains should be run by independent motors, and as frequently as on the elevated roads, and at a speed of at least 25 miles per hour, including stops, This would enable the trip to be made:

From Wall Street.	Distance. Miles.	Time Minutes.
To City Hall	½	1¼ to 1½
To Union Square	2	5 to 6
To Madison Square	2½	6 to 7
To Forty-second Street	3½	9 to 10

"As we have already stated, the act prohibits laying out any routes of sufficient length to afford rapid transit. Hence, we have not undertaken to make any estimate of cost of a viaduct line, as the expense of necessary surveys, etc., would be too great for individual citizens to pay out of their own pockets.

"We will say, however, that we have made sufficient examinations to convince us that a viaduct line, such as we have described, can be laid out and built for a sum upon which capital might reasonably be sure of return, and one constantly increasing in amount."